RAY SOCIETY.

THE BRITISH NUDIBRANCHIATE MOLLUSCA.

BY

THE LATE JOSHUA ALDER AND THE LATE ALBANY HANCOCK.

PART VIII (SUPPLEMENTARY).

BY

SIR CHARLES ELIOT, D.C.L., C.B., K.C.M.G., ETC.

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A

MONOGRAPH

OF THE

BRITISH NUDIBRANCHIATE MOLLUSCA:

WITH

Figures of the Species.

PART VIII (Supplementary).

FIGURES BY

THE LATE JOSHUA ALDER AND THE LATE ALBANY HANCOCK, AND OTHERS.

TEXT BY

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LONDON:

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BRITISH NUDIBRANCHIATE MOLLUSCA.

I.

When examining in 1905 the specimens and papers which were left by Alder and Hancock and deposited in the Hancock Museum at Newcastle-on-Tyne, I found that they had contemplated the publication of a supplement to their Monograph on the British Nudibranchiata and had collected some materials for this purpose. This supplementary part was to have contained ten or twelve plates illustrating the anatomy of the Limapontiidæ and Elysiidæ together with figures of the following species: *Doris testudinaria, D. loveni, D. ulidiana, Crimora papillata, Doto cuspidata, Embletonia pallida, Lomanotus portlandicus, *Eolis adelaidæ, E. cærulea, *E. farrani var., *E. pellucida, *E. landsburgii, Antiopa hyalina, *Limapontia nigra, Limapontia depressa, *Acteonia cocksi, *Acteonia corrugata, Elysia viridis, *Diphyllidia lineata.* Neither the anatomical drawings nor those of the species marked with an asterisk are forthcoming.[1] Some of them were probably coloured or improved reproductions of the figures accompanying the article "On a Proposed New Order of Gasteropodous Mollusca" (Alder and Hancock **3**) published in 1848. The remainder are preserved and a selection from them forms the basis of the present work. They are mostly by Hancock, who, contrary to what might have been expected of so careful an anatomist, was untidy in his handwriting and drawings. Most of the animals are represented by several rough sketches, somewhat uncertain in outline and only partly coloured. They were apparently revised and copied several times, and the sets of figures representing *Lomanotus, Hero, Limapontia* and *Antiopa* (= *Janolus*) are noted as complete. Of the other species there are as a rule only one or two figures sufficiently finished to merit reproduction. Only three of the figures (two of *Elysia viridis* and one of *Eolis inornata*) are by Alder; they are complete and carefully executed. The total number of old figures reproduced is forty-five, and I have added to them twenty-three new ones drawn from living specimens of *D. testudinaria, D. maculata,*

[1] Or at any rate not identifiable with certainty. Several figures of Æolids, though fairly well executed, are marked only by numbers, and it seems useless to reproduce them or to discuss what they represent. *E. pellucida* and *E. landsburgii* are figured in the Monograph, but Hancock has left a note that he thought the plates unsatisfactory. I have, however, found nothing better among his papers.

Pleurophyllidia loveni (probably the *Diphyllidia lineata* of Hancock), *Cenia* (*Acteonia*) *cocksi*, and *Cumanotus beaumonti*, or giving some details of the dentition and anatomy of these and a few other species.

As is natural in a supplementary part, the majority of the animals figured are rare, but this rarity may be the result of accidental circumstances as much as of real scarcity. *Limapontia*, *Cenia*, and *Alderia* escape notice owing to their small size. *Doris testudinaria* is commonly confounded with *D. tuberculata*, but is not uncommon on our southern coasts and probably elsewhere. *Pleurophyllidia loveni* appears to live in sand at moderate depths and can as a rule be obtained only by dredging. *Doris maculata* and *Crimora papillata* are perhaps southern forms which only occasionally reach our shores. *Cumanotus* on the other hand appears to be a northern form which is, nevertheless, established at Plymouth. It is probable that it occurs on other parts of the British coast but is local in its distribution.

The drawings are accompanied by various notes in Hancock's writing, mostly disjointed and not prepared for publication. They are cited from time to time in the pages which follow, but the text of the present part is not otherwise based on them. To the synopsis of the British fauna and the descriptions of new species I have added chapters on the distribution, nomenclature, bionomics, classification, and affinities of the Nudibranchiata. It is remarkable how little of Alder and Hancock's work has proved to be incorrect, and later researches have added less than might be expected to their accounts of such species as they were able to investigate thoroughly. But in the Monograph (which does not, however, represent all their work) they neglect several families, and since their time numerous new forms have been discovered which have materially affected our ideas as to the morphology and classification of the group. I have endeavoured to indicate the character and extent of these additions to our knowledge, at least as far as they concern the Nudibranchiata of the northern Atlantic.

I must thank the Council of the Hancock Museum at Newcastle-on-Tyne for their courtesy in lending me all the drawings, notes, specimens, and microscopic preparations left by Alder and Hancock.[1] The preparations consist chiefly of radulæ and have been used for some of the figures of teeth (*Crimora*, *Hero*, *Tritonia alba*, and *Doris testudinaria*) included in the present plates.

My best thanks are also due to Professor W. C. McIntosh for the loan of a collection of St. Andrews Nudibranchs, and to Dr. E. A. Allen, Mr. W. I. Beaumont, Mr. R. L. Crawshay, Mr. R. Elmhirst, Mr. G. P. Farran, Mr. R. A. Tod, Mr. E. A. Smith, and Mr. C. W. Walton for specimens and information. To Mr. T. J. Evans, Lecturer in Zoology at the University of Sheffield, I am indebted for much assistance and for some of the figures.

[1] These included material from India and Ceylon. The results of my examination of the Nudibranchs of this region were published in the Proc. Zool. Soc., 1906.

II.

VARIATION AND DISTRIBUTION.

The Nudibranchiata exhibit great variation within the limits of the recognized species, and it is probable that many of these should be reduced to the rank of varieties. Even the land-slugs, though of sober hue, show that the soft integuments of the Mollusca are very susceptible of changes in colour. In the Nudibranchiata these changes are more conspicuous because whole divisions exhibit not only a greater range and brilliancy of coloration, but also an unusual fluidity and flexibility of outline. Many genera (especially in the Doridida Phanerobranchiatæ) are provided with appendages which seem to be less specialized for particular functions than are, for instance, the limbs of the Arthropoda. Their precise number or shape is immaterial to the animal. Thus *Polycera quadrilineata*[1] has typically two unbranched dorsal appendages, one on either side of the branchiæ, but occasionally these appendages are absent and frequently one is large and the other small. Sometimes they are bifid from the base upwards and appear to be four; sometimes they are palmate and bear five to eight small branches. Similarly the branchiæ vary from five to nine, and the processes on the oral veil (considered to be typically four) from four to thirteen. The tubercles on the dorsal surface not only vary greatly in number but are sometimes separate and sometimes confluent, forming lines or ridges. These variations can hardly be regarded as monstrosities like a bifid tentacle or a double eye. They merely illustrate the tendency to vary when variation does not decrease efficiency. The function of the appendages in *Polycera* is probably to protect the branchiæ by making it more difficult for external objects to touch them, and appendages of different shapes may perform this function equally well. Similarly the rhinophore sheaths of *Lomanotus genei* usually bear papillæ, but these may vary not only in different specimens but even on the two sides of the same animal, to such an extent that I have seen the left rhinophore sheath with a smooth margin while the right bore five long processes. Other genera in which the external shape offers many modifications are *Bornella*, *Marionia*, *Ceratosoma*, *Miamira*, and *Triopa*.

The appendages which have definite functions such as the rhinophores and branchiæ have naturally more definite and constant shapes, but the number is not constant either in the cerata of Æolids or the branchial plumes of Dorids. These latter also show some variation in form. For instance, in *Staurodoris* and *Chromodoris* they are typically pinnate but have a tendency to divide and become bipinnate.

Even the anatomical characters are sometimes variable, especially when there is a question of chitinous structures which may or may not be developed on soft organs. In

[1] See Elmhirst in Annals of Scottish Natural History, October, 1908, pp. 227—230, for some statistics as to the variations of this species.

these cases there is often a doubt as to whether the divergent specimens are really identical, but it would seem that in *Doris* (especially in the sections *Stauvodoris* and *Archidoris*) a slight labial armature may be present or absent, and specimens of *Acanthodoris* from New Zealand identified by Bergh with *A. pilosa* have no armature of hooks on the verge. With regard to the radula no general statement can be made. In some groups, *e. g.* the Polyceridæ, it is remarkably constant, and it may be said that as a rule narrow radulæ with differentiated teeth show less variation than those which are wide and contain many teeth of much the same pattern. The shape of the separate teeth and the general proportions of the arrangement are usually preserved within the same species, *e. g.* a short, broad radula does not become a long and narrow one. But the number and size of the teeth may vary greatly in individuals of different age and size, or sometimes without special reason. Thus in *Tritonia hombergii* the formula varies from 45 × 120.1.120 to 100 × 265.1.265. In Æolids the number of denticles on the teeth is often variable, particularly when the teeth are broad as in *Æolidia*.

Apart from other causes, age may affect not only the size but the shape of Nudibranchs. As a rule the older animals are larger, deeper in colour, and, if the species bears tubercles, pits, or processes, show these in a more developed form. But sometimes the opposite happens. The appendages do not keep pace with the general growth of the animal, and their shape becomes obscured. Thus in the young *Plocamopherus* the dorsal appendages are relatively larger and more branched than in the adult. According to Trinchese the young *Lomanotus eisigii* is æolidiform in appearance, but the skin grows up between the cerata, which finally become a row of points on an undulating lateral membrane. In the young *Crosslandia* (allied to *Scyllæa*) the wings are bifid and bear finger-like processes. In the adult the bifurcation and the processes both disappear, and the wing becomes a roughly triangular flap.

But it is in colour that the variations of Nudibranchs are most striking. The common *Doris tuberculata* is protean in this respect. Pure yellow specimens are sometimes found, but usually there are mottlings of one or more tints on a light ground. The range of colours comprises red, yellow, pink, brown, and grey of many shades, purple, slatey blue, sage green, and perhaps others. In a series of specimens received from the Isle of Man slate-colour and greyish-blue predominate. At Plymouth red and yellow, though not universal, are very common. I have occasionally seen there bright yellow specimens marbled with bright red which might have competed with any tropical *Dorid* in brilliancy. It is worth noticing that this variation in colour and pattern, though luxuriant, is not unlimited. As far as I know, the markings of *D. tuberculata* never form stellate patterns on the back, as they do in the equally variable *D. testudinaria*, and there are never any spots on the under side of the mantle.

These variations are probably due in part to climate. At Plymouth many marine animals as well as seaweeds are reddish. Tropical Nudibranchs, as well as the Ascidians and sponges among which they live, are more deeply and gorgeously coloured than those of temperate and northern waters. These last are often of a semi-pellucid white, and when the coloration appears brilliant it will generally be found to consist of bright spots distributed over a colourless surface, and not of large pigmented areas. Colour also depends to some extent on food, especially among the Æolids. Though some of their

markings may be due to pigment in the integuments, yet the predominant colour is generally determined by the hepatic diverticula as seen through the transparent cerata, and these vary with the food. Thus *Fiona marina* is of a greyish-blue when it feeds on *Velella*, but of a pale brown when it eats young barnacles. *Coryphella gracilis* (orange-brown) and *C. smaragdina* (green) are probably similar variations produced in the same animal by different diets. So, too, in *Favorinus albus* the hepatic diverticula may be white, greyish-brown, coffee-coloured, red, or green, and white spots may be present or absent on the integuments. But though Trinchese noticed and figured all these variations at Genoa, Vayssière found that they did not exist at Marseilles.

The common *Æolidia papillosa* is almost as variable in colour as *D. tuberculata*. Hecht mentions a case of its becoming violet after eating *Actinia equina*, and apart from such special and temporary modifications the species comprises several races, as described by Alder and Hancock, distinguished by their size and the length of the cerata as well as by the colour, which ranges through many shades of grey, buff, yellow, brown, rose, and green. As in *D. tuberculata*, the specimens found on our southern coasts show a tendency towards a rosy or pinkish coloration. The colour of Dorids is to some extent affected by their food, though less than that of Æolids. The brightly coloured species often frequent and feed on similarly bright sponges[1] or Ascidians, and when they do not obtain their usual food in confinement they lose their colour. Hecht mentions that *Elysia viridis* (which usually feeds on *Codium*) became much larger when fed by him on Cladophora, and developed red cells in the epithelium.

This great variability naturally makes the definition of species a difficult business. In particular it is very hard to say whether preserved Nudibranchs which are similar but come from widely distant localities (such as Great Britain and the Falkland Islands) are specifically identical or not. Even when the characters of a living specimen are certain, their value as specific characters can be determined only after comparison with a series of other specimens. Hence species which are based on one (or even on two or three) specimens are nearly always open to suspicion, unless their peculiarities are so decided as to make them also representatives of separate genera. Alder and Hancock doubtless erred in creating too many species, particularly in the Æolididæ, but the error is on the right side, for if certain types only are selected as species and others are dismissed as varieties, there is danger that the varieties will be neglected and the real multiplicity of forms forgotten. Yet morphologically a variety may be as important as a species. The only difference is that if two forms are connected by intermediate gradations they are called varieties, whereas if the connecting links are absent they are called species. Thus the forms described below as *Doris verrucosa* and *D. maculata* are as distinct as any accepted species. They can easily be distinguished in appearance, and present real structural differences. Yet it is highly probable that they pass into one another through the medium of *Doris pseudoverrucosa*, and also pass into many other forms which have received specific rank such as *D. januarii*, *ocelligera*, *atypica*, and *falklandica*. But it is clearly safer to maintain the two species as separate until it is proved that they pass into one another. And even then (provided our conception of species is

[1] Thus the red British Dorids *Rostanga coccinea* and *D. flammea* eat red sponges such as *Microciona atrasanguinea*.

not too rigid) there is no harm in retaining the specific names if the different varieties or races are found in different districts, as is often the case. But if eggs laid by similar parents in the same locality produce indifferently *D. verrucosa* and *D. maculata*, then the two forms must be registered as mere varieties. But though we are apt to overlook the luxuriant variability of the Nudibranchiata if we pay attention only to the series of forms selected as specific types, yet it must be admitted that, taking the classification as a whole, species have been unduly multiplied, and that of those registered at least a third are superfluous.

The question of variation and specific distinction is intimately connected with another, namely the distribution of Nudibranchs. It is unfortunately impossible to treat this interesting subject with the accuracy one would desire, because though the Nudibranch faunas of the north-eastern Atlantic and the western Mediterranean are well known, the available data for the tropical Atlantic are extremely scanty, and the specific identity of northern and southern forms is often uncertain.

The British coast-line extends over about thirteen degrees of latitude, and it is not surprising to find that two faunistic districts overlap within this considerable area. As Alder and Hancock have pointed out, the northern fauna is continued far south on our east coasts, whereas on the western side the northerly set of the currents and the influence of the Gulf Stream carries southern forms to the western coasts of Scotland and Ireland. Thus *Doris verrucosa*, which according to all other records is a definitely southern form, has been found, not only near Plymouth in England, but at Ballynakill and in the Firth of Clyde. The meaning of this phenomenon seems to be not so much that the northern fauna fails to reach our southern coast, as that on the western coast it is reinforced by a certain number of southern genera and species. But some northern forms, such as *Aldisa zetlandica*, *Cadlina repanda*, *Coryphella salmonacea*, have not been recorded from our southern coasts.

The fauna of Scandinavia is substantially the same as that of the northern parts of England and Scotland, and a considerable number of its species penetrate to the Arctic regions. The following forms and perhaps others have been taken within the Arctic Circle :—

Dendronotus, 3 species.
Doto coronata.
Pleurolewra walteri.
Cratena or *Cuthona*, 3 species.
Coryphella, 7 species.
Cumanotus laticeps.
Favorinus albus.
Chlamylla, 4 species.
Hero formosa.
Elysia viridis.
Limapontia nigra.
Doris tuberculata.
Aldisa zetlandica.
Cadlina repanda.
Acanthodoris, 2 species.
Adalaria proxima.
Lamellidoris, 2 species.
Polycera, 2 species.
Issa, 2 species.
Triopa lacera.
Idalia pulchella.
Ancula cristata.

To these should doubtless be added other Nudibranchs which have been captured in northern but not strictly arctic waters, such as *Bathydoris* and *Doridoxa*. But the list, taken as it is, probably gives a fair idea of the arctic fauna. The only genera in it which

are unknown in the temperate Atlantic are *Chlamylla* and *Pleurobranchæa*.[1] The Cladohepatica number twenty-four and the Holohepatica fifteen species. Among the former Æolids (sixteen) are predominant: among the latter phanerobranchiate Dorids (twelve). The true cryptobranchiate Dorids are only three.

The fauna of the Atlantic coast of France appears to be practically the same as that of south England. All the Nudibranchs recorded by Hecht from Roscoff near Brest are described by Alder and Hancock. At Arcachon,[2] too, the majority of Nudibranchs recorded are also known at Plymouth, but southern forms such as *Spurilla mediterranea* begin to make their appearance, and the commonest Dorid is *D. verrucosa*, which is rare with us. But it is not till we reach the coast of Portugal that the southern or subtropical element contributes a considerable proportion of names.

The Nudibranchs of this region, as described by M. d'Oliveira,[3] comprise the following:

Doridopsis and *Doriopsilla*, } 4 species.
Doris, 2.
Jorunna, 1.
Platydoris argo.
Chromodoris, 3.
Goniodoris, 1.
Polycera, 1.
Triopa, 1.
Pleurophyllidia, 2.
Tritonia, 1.
Marionia, 1.
Facelina, 4.
Coryphella, 1.
Amphorina, 1.
Æolidiella, 1.
Doto, 1.
Hermæa, 1.
Elysia, 1.

In the above list the genera *Doridopsis*, *Doriopsilla*, *Chromodoris*, *Platydoris*,[4] and *Marionia* are characteristic of the warmer seas, and Portugal is probably their northern limit in the Atlantic.

The Nudibranchiata of the eastern coast of the United States and Canada—that is, of the north-west Atlantic—are not well known, though they have formed the subject of several publications.[5] The lists which have been compiled are probably not exhaustive, and it is difficult to say how far the forms described are specifically the same as those found in the north-eastern Atlantic or merely similar to them. In any case the resemblance between the two faunas is close. The principal American genera are:

Coryphella, 9 sp.
Æolidia papillosa.
Cratena (*Cuthona*), 4.
Galvina, 2.
Tergipes, 1.
Embletonia, 2.
Fiona, 1.
Scyllæa, 1 or 2.
Dendronotus, 2 or 3.
Doto, 2.

[1] The distribution of this genus is very strange. All the other known species inhabit the tropical Indo-Pacific.

[2] Cuénot, Doridiens d'Arcachon, 1901; *id.* Eolidiens d'Arcachon, 1906.

[3] Opisthobranches du Portugal, Coimbra, 1895.

[4] N.B.—The designations *Platydoris testudinaria* and *P. planata* are not correct.

[5] Gould, Invertebrata of Massachusetts, and several catalogues by Verrill.

Pleurophyllidia, 1 (probably *Pl. undulata*).
Hermæa, 1.
Alderia, 1.
Elysia, 1.
Doris verrucosa.
Geitodoris complanata.
Cadlina, 1.
Acanthodoris pilosa, and about three other uncertain species.
Lamellidoris bilamellata, and about four other uncertain species.
Adalaria, 1.
Issa, 2.
Polio, 1.
Polycerella, 1.
Idalia, 1.
Ancula, 1 or 2.
Heterodoris, 1.
Doridella, 2 (probably = *Corambe*).

Here as in the north-eastern Atlantic, the Cladohepatica (about thirty) are more numerous than the Holohepatica (about twenty), and among the latter the Phanerobranchiata are greatly in the majority. I have not found any record of the occurrence of *D. tuberculata*, but it is not likely that it is entirely absent.[1] All of the above genera are represented on this side with the exception of *Polycerella* and the little-known *Heterodoris* from deep water.

From various parts of the semi-tropical Atlantic, such as the Azores, the Sargasso Sea, Madeira, the coast of Morocco, and the Canaries, are recorded the following as well as some less certain forms:

Cratena and *Cuthona*, 2 sp.
Spurilla, 1.
Fiona, 1.
Glaucus, 2.
Scyllæa, 1.
Phylliroe, 1.
Dotilla, 1.
Doris verrucosa.
Discodoris, 2.
Platydoris, 1 or more.
Aldisa, 1.
Chromodoris, 1.
Euplocamus, 1.
Plocamopherus, 1.
Doridopsis, 1.
Doriopsilla, 1.
Phyllidiopsis, 1.

The above list is perhaps not very representative, as it is to some extent the result of pelagic collecting, and hence contains an undue proportion of forms which swim or live on floating seaweed. But even so, the Cladohepatica are no longer in the majority as in more northern latitudes.

The records from the Mediterranean are ample, but they refer almost entirely to Marseilles, Naples, and the Adriatic, so that we can say nothing about the fauna of the eastern and southern portions. The following is a rough analysis of the genera based chiefly on the works of Bergh, Trinchese, and Vayssière. Some Mediterranean naturalists have shown a tendency to create superfluous species (*e. g.* in *Doto* and *Marionia*), and the numbers given here are only approximate:

Æolidiella, *Spurilla*, etc., 5.
**Hervia and Rizzolia*, 2.
Galvina, 2
**Capellinia*, 2.
Amphorina, 2.
Coryphella, 5.

[1] Mr. F. N. Bulch, of Boston, Mass., who has most kindly given me some information on this point, agrees that there is no certain record of the occurrence of this species on the Atlantic coast of the United States, but thinks that *D. diademata*, though wrongly described as phanerobranchiate, is really identical with it or at least nearly allied.

Favorinus, 2.
**Flabellina*, 2.
Facelina, 10.
Forestia (= *Calma*), 1.
Other Æolids, 5.
**Glaucus*, 1.
Antiopella, 1.
**Madrella*, 1.
Hero, 1.
Pleurophyllidia, 2.
Tritonia, 5 mentioned.
**Marionia*, 8 „
Doris, 3.
**Discodoris*, 3.
**Platydoris*, 2.
Aldisa berghi.
**Peltodoris*, 1.
**Paradoris*, 1.
**Baptodoris*, 1.
Thordisa, 1.
Cadlina, 1.
Rostanga, 2.
Jorunna, 2.
**Chromodoris*, 11.
**Doridopsis*, 2.
**Doriopsilla*, 1.
Fiona, 1.
Doto, about 10 described.
**Tethys*, 1.
Lomanotus, 2.
Hancockia, 2.
Scyllæa, 1.
**Phylliroe*, 1.
Elysia, 2.
Hermæa, 2.
**Ercolania*, 2.
Limapontia, 1.
Polycera, 2.
**Greilada*, 1.
Triopa, 1.
Ægires, 2.
Goniodoris, 2.
Idalia, 1.
**Euplocamus*, 1.
**Drepania*, 2.
Lamellidoris græffei.

The genera marked with an asterisk are not recorded from the British Coast.

The Mediterranean fauna is richer than that of the northern Atlantic, for nearly all groups are well represented. The northern genera *Æolidia*, *Dendronotus*, *Lamellidoris*,[1] *Acanthodoris*, and *Adalaria* are not recorded, but new Cladohepatic forms, such as *Flabellina* and *Tethys*, make their appearance. Nearly all the northern genera of Cryptobranchiate Dorids remain, and are supplemented by *Discodoris*, *Platydoris*, and allied forms. Probably the fauna is even more comprehensive than it seems, for while the presence of new species is certain, the absence of northern forms may prove to be incorrect.

A considerable number of species from Bermuda have received names, but the descriptions are slight and do not always accord with the genera to which the specimens are assigned. But it would appear that at this point (about 32° N.) the northern fauna is considerably modified by the addition of many brightly coloured Doridida and Elysiidæ.

The fauna of the tropical Atlantic is known by small collections from the Cape Verde Islands (about 20° N.), the West Indies (mostly from between 15° N. and 20° N.), and the province of Alagoas in Brazil (about 10° S.). On the African side no specimens from the equatorial Atlantic have been examined.

The following list tabulates the results obtained :—

[1] *L. græffei* is a somewhat uncertain form.

Cape Verde.	West Indies.	Brazil.
Tritonia, 1.		*Marionia*, 1.
Doris, 1.		*Doris verrucosa.**
Discodoris, 2.	2.	2.
Geitodoris, 1.	2.	
Peltodoris, 1.	1.	1.
	Platydoris, 1.	
	Aphelodoris, 1.	
	Phlegmodoris (?), 1.	
		Thordisa (?), 2.*
Rostanga, 1.		
Cadlina, 1.		
Chromodoris, 1.	5.	
Doridopsis, 1.	2.	1.
Doriopsilla, 1.		
	Phyllidiopsis, 1.	
Plocamopherus, 1.		
	Nembrotha, 1.	
	Bornella, 1.	
Doto, 2.	*Heromorpha*, 1.	
	Tethys, 1.	
Spurilla, 1.	*Æolidiella*, 1.	*Spurilla*, 1.
Amphorina, 1.		
Phidiana, 1.	1.	1.
Facelina, 1.		
Favorinus, 2.		
		Pleurophyllidia, 1.*
	Phyllobranchus, 1.	
	Tridachia, 2.	
	Elysia, 2.	

The forms marked with an asterisk were taken about 28° S., and hence outside the tropics strictly speaking.

In drawing any conclusion from the above lists it must be remembered that they are fragmentary, and that the littoral zone in the regions where the collections were made is probably not so favourable for Nudibranchs as in the Indo-Pacific. This is certainly true of long stretches on the West Coast of Africa. It is therefore probable that an adequate knowledge of the Atlantic Nudibranchs can be obtained only by dredging. Still, after making all allowance for possible lacunæ, it is interesting to notice that many of the commonest and most striking Indo-Pacific forms (such as *Hexabranchus*, *Kentrodoris*, *Asteronotus*, *Ceratosoma*, *Trevelyana*, *Phyllidia*, and *Placobranchus*) are not recorded from the tropical Atlantic, and also are not replaced to any considerable extent by other large or brilliantly coloured forms. The specimens hitherto obtained are mostly modest in dimensions and colour, and do not indicate that there is any great difference between the

tropical and temperate faunas. But the occurrence of *Nembrotha* and *Bornella* (typical Indo-Pacific forms) in the West Indies suggests the need of further exploration.

A collection of Nudibranchs from S. Africa, comprising about thirty-five species, has been described by Bergh. This region is in about the same latitude as southern Brazil, and *Doris verrucosa* occurs in both. But the Cape is clearly a meeting-place for the two oceans, and it is hard to say which forms in the collection should be regarded as Pacific and which as Atlantic, particularly as the specimens come from both the east and west coast.

But whatever may be the real character of the tropical Atlantic fauna, it is interesting to see that the waters of the south Atlantic beyond the tropics contain forms very similar to those found in the north, if not identical with them. *Doris tuberculata* and *Cadlina repanda* are recorded from the east coast of Patagonia (42° S.), and the former also from the Antarctic south of Cape Horn (64°—65° lat. S. and 64° long. W.). On the coast of the Falkland Islands have been found:

Tritonia, 1.			
Diaulula, 1.			
Doris, 1,	nearly allied to		*D. verrucosa.*
Acanthodoris, 1.			
Cratena, 1.			
Galvina, 1	,,	,,	*G. flava.*
Coryphella, 1	,,	,,	*C. lineata.*
Ælolidia, 1	,,	,,	*A. papillosa.*

It is possible that some of the above may be specifically identical with north Atlantic forms, and in any case all the genera are found there except *Diaulula*, which is not very different from *Thordisa* recorded from the temperate Atlantic. But further south in the Antarctic we find new types such as *Notælolidia* and *Tritoniopsis*, for which no counterparts have been found in Arctic regions.

Thus our information (though imperfect for many regions) indicates that the fauna of the Atlantic is more homogeneous than that of the Pacific. The tropical Nudibranchs are not sharply distinguished from the temperate: the temperate zones north and south of the equator seem to have the same genera and to some extent the same species. Thus *D. verrucosa* and *D. tuberculata* are recorded from both. There are definitely northern forms, such as (*a*) *Dendronotus*, (*b*) large Ælolids such as *Chlamylla* and some species of *Coryphella*, (*c*) the Pseudorididæ, viz. *Acanthodoris*, *Lamellidoris* and *Adalaria*, (*d*) various Polycerids. These make the great majority of the known fauna within the Arctic Circle; most of them are abundant as far south as the British Isles, but they nearly all[1] disappear before the Mediterranean. But, so far as can be judged from our scanty records, they reappear in the southern hemisphere, for an *Acanthodoris* and *Ælolidia serotina* (closely allied to *A. papillosa*, if not a variety of it) have been found in the Falkland Islands. In the northern hemisphere the genera *Chromodoris* and *Doridopsis* mark the transition to warmer waters, beginning about Lat. 40° N. The fauna of the Cape makes it probable that much the same phenomenon occurs in the southern hemisphere. The genera which are common to both cooler and warmer waters are more brightly coloured in the latter.

[1] The small and doubtful *Lamellidoris græffei* is the only representative in the Mediterranean of the large group Pseudodorididæ.

For instance, the species of *Doto* and *Favorinus* are more brilliant and variable in the Mediterranean than on our coast, *Marionia* is more gorgeous than *Tritonia*, the modest *Aldisa zetlandica* and *Geitodoris planata* are replaced by the red *A. berghi* and *G. reticulata*. South of about 40° N. red and yellow Dorids are common (*e. g. Platydoris argo*, *Baptodoris cinnabarina*, *Doriopsilla areolata*, *Plocamopherus maderæ*), but no forms have yet been discovered showing such extraordinary brilliance of colour as *Hexabranchus*, *Chromodoris*, *Miamira*, etc., in the Indo-Pacific.

A glance at the map will show that Nudibranchs living near Greenland and Spitzbergen, or their larvæ, can be carried to Behring's Sea by the north coast of either Europe or America without being exposed to any unaccustomed temperature. The passage between the two oceans is even easier round the extremities of Africa and South America. But the migration of a marine animal from the tropical Atlantic to the tropical Pacific necessitates, not only a long journey, but changes of temperature which would probably be fatal to all but pelagic or deep-sea species. Hence it is not surprising if the Nudibranchs (and, indeed, all the Mollusca) of the tropical Atlantic and of the Mediterranean have little in common with those of the tropical Pacific. Some pelagic forms, such as *Scyllæa*, *Glaucus* and *Fiona*, seem to be really cosmopolitan. *Platydoris argo* is thought by Bergh to occur in the Indo-Pacific. *Discodoris notha*, *Phyllidiopsis papilligera*, *Thecacera maculata* and *Nembrotha gratiosa* are very like *D. concinna*, *Ph. carinata*, *T. maculata* and *N. affinis* from tropical Pacific waters. But in no case is the identity certain. *Goniodoris castanea* is recorded from the Atlantic, the Mediterranean, Suez, and New Zealand, but its presence at Suez is no doubt attributable to the Suez Canal.

The same want of complete equivalence seems to extend to the generic as well as to the specific divisions. Of the Atlantic species referred to such genera as *Discodoris*, *Thordisa* and *Trippa*, many are marked by their authors with a query or are admitted to possess abnormal characters. Three of the Dorids from South Africa described by Bergh are left without any precise generic designation because they do not fit in to any recognized group. The fact is that the scheme of classification used for tropical Dorids was devised for the Indo-Pacific forms and suits those of the Atlantic very imperfectly.

The west coast of America is, as a faunistic region, distinct from the Indo-Pacific. Information as to the Nudibranchs found south of California is not copious, but *Chromodoris* seems rather scarce, and the characteristic Indo-Pacific genera, such as *Hexabranchus*, *Phyllidia*, *Bornella*, *Melibe*, are not mentioned. The genera recorded (if they can be regarded as representative) indicate a general resemblance to the Atlantic fauna, though most of the species are different. The chief of them are *Archidoris*, *Anisodoris*, *Diadula*, *Euplocamus*, *Æolidia*, *Phidiana* and *Cratena*. For the coasts of California and Alaska we have more details as to the distribution of Nudibranchs, which resembles that prevailing on the eastern side of the Atlantic in several interesting points. *Dendronotus*, *Tritonia*, and Æolids are well represented, the latter both by special types and by Atlantic genera, such as *Æolidia* and *Flabellina*. The Polyceridæ (*Polycera*, *Ancula*, *Thecacera*, *Ægires*, and several new genera) and the Pseudodoridida (*Acanthodoris*, *Lamellidoris*, *Adalaria* and *Akiodoris*) are very numerous. Cryptobranchiate Dorids are represented by *Archidoris*, *Aldisa*, *Rostanga*, *Cadlina*, *Diaulula*, *Discodoris*, and allied genera. On the Californian coast appear a few species of *Doridopsis* and *Chromodoris*,

the latter extending as far north as Puget's sound (about Lat. 49° N.). Thus, exactly as on the eastern coast of Europe, we have a northern fauna characterized by Æolids, *Dendronotus*, Polyceridæ, Pseudodorididæ, and such cryptobranchiate Dorids as *Archidoris* and *Cadlina*. A little further south some forms, such as *Dendronotus*, cease to be recorded, and the southern genera *Doridopsis*, *Chromodoris* and *Discodoris* begin to appear, extending rather further north than their known Atlantic range.

The following north Pacific forms are considered specifically identical with Atlantic Nudibranchs, though most of them are also given varietal names: *Archidoris tuberculata*, *Dendronotus arborescens*, *Acanthodoris pilosa* and *Lamellidoris bilamellata*, whereas the species of *Adalaria*, *Cadlina*, *Ægires* and *Polycera* are regarded as separate, but nearly allied to *A. proxima*, *C. repanda*, *Æ. punctilucens* and *P. lessonii*. There is not much difference between varieties of the same species and nearly allied but distinct species. They both represent successive stages in the same process, namely, that a northern circumpolar fauna becomes slightly differentiated in the two oceans.

Closely allied species of *Diaulula* and *Æolidia*, or perhaps varieties of the same species, are recorded from the southern Atlantic and from California. Though the fauna of New Zealand contains many forms unknown to the northern Atlantic and northern Pacific, it includes animals described as *Acanthodoris pilosa*, *Doris tuberculata*, *Goniodoris castanea*, and a species of *Drepania* not very different from those found in the Atlantic and Mediterranean. But the identity of the species mentioned is not beyond dispute.

Thus the distribution of those Nudibranchs which inhabit the littoral zone or moderate depths seems to depend mainly on climate. The faunas of the northern and southern Atlantic as well as those of the northern Atlantic and northern Pacific show considerable similarity in genera and even in species. Some species are common to the north Atlantic and south Pacific, and are probably cosmopolitan in temperate waters. *Æolidia*, *Chlamylla*, *Dendronotus*, *Cadlina*,[1] all the Pseudodorididæ, and several genera of the Polyceridæ are almost or quite unrecorded in the tropics, and, though occurring in temperate regions, are most numerous in cold waters; exactly the opposite is true of *Chromodoris*, *Doridopsis*, *Discodoris*, *Marionia*,[2] and others. Dorids are much more abundant in tropical than in cold waters, and Æolids seem to be less abundant. But the fact that they are less conspicuous, and are not numerous in the accessible localities (*e. g.* reefs) where Dorids abound, may have something to do with this apparent scarcity. All collections made in or near Arctic and Antarctic waters show a considerable preponderance of *Cladohepatica*, particularly Æolids. There is less resemblance between the tropical faunas of different oceans than between the temperate faunas, because for geographical reasons intercommunication between the temperate seas is easier. Scanty as are our records for the tropical Atlantic, they indicate a great discrepancy in genera with that large part of the tropical Pacific which comprises India, the Red Sea, East Africa, N. Australia, Polynesia, and the Malay Archipelago. With the West Coast of tropical

[1] *Tyrinna* also, a genus allied to *Cadlina*, is recorded from temperate waters: Chile, Lat. 41 S.

[2] The known species of *Marionia* are recorded only from the warmer seas, but *Tritonia*, which replaces it in northern waters, is also found (though scantily) in the tropics.

America the discrepancy is less, but the records from both sides are too meagre for positive conclusions.

The pelagic forms such as *Phylliroe*, *Scyllaea*, *Glaucus*, and *Fiona*, appear to be cosmopolitan and differ little in the various seas which they frequent. Perhaps the same is true of deep-sea forms, but the data are not sufficient to support any conclusions. Different species of the genus *Bathydoris* have been found in the Arctic Atlantic (1870 fathoms), the Equatorial Pacific (2425 fathoms), and in the Antarctic at moderate depths.

III.

NOMENCLATURE.

The nomenclature of the Nudibranchiata has been considerably modified since the time of Alder and Hancock, and changes took place even during the publication of the Monograph, for the names used in the Synopsis of Genera (Part VII, Appendix, pp. xvi—xxiv) are in many cases not those used in the body of the work. Such changes are due to two principal causes: Firstly the discovery that there are objections to the use of a name (the commonest objection being that it is already employed for some other animal), and secondly the fusion or subdivision of existing species and genera.

Alder and Hancock themselves recognized that *Eumenis* and *Oithona* must be discarded as preoccupied. *Antiopa*, *Diphyllidia*, and *Cavolina* are in the same plight, and the specific names of *Glaucus forsteri* and *Fiona nobilis* have been replaced by *atlanticus* and *marina*. I do not, however, think it is proved that *Cadlina repanda* is synonymous with the *Doris obvelata* of O. F. Müller, as some authors contend, and unless the identity is beyond all dispute it seems a pity to make any change. I confess that I sympathize with those zoologists who wish to be as conservative as possible in applying the rule of priority. It is a mere means for conveniently deciding disputed cases, not a moral law which must be enforced whether convenient or not. When two names are both in practical use it is most desirable to eliminate one. Otherwise there is confusion, and if, as sometimes happens, both names are retained in lists, the genus may be credited with an extent and an abundance of species which are deceptive.[1] But I cannot see that anything is gained, whereas much is obviously lost, by discarding a well-known name in favour of an obscure and forgotten one when there is practically no competition between the two. For instance Alder and Hancock originally described an animal as *Eolis pallida*. Then in the Monograph they altered the name to *Eolis tricolor*, because they found that the colours of the animal were not habitually pale. According to a rule subsequently accepted by zoologists this alteration was incorrect, and the rule is a good one for the guidance of authors, since changes in names once given are confusing. But nothing whatever is gained by the learning which disinters the forgotten designation *pallida* and substitutes it for the *tricolor* of the Monograph, and much inconvenience is caused, for the species has been described and figured by Bergh and Trinchese under the name of *tricolor*, so that in this and very many other cases the best information about an animal would not be found under its authorized name. A specialist may thread his way through the labyrinth of synonymy, but a naturalist consulting the literature of a group with which he is not specially acquainted is baffled at every turn by new names which correspond to little in the descriptive literature. Equally unnecessary and far more inconvenient is the substitution of *Tethys* for *Aplysia* as the name of a well-known Tectibranch, and the consequent use of some other designation (*e. g. Phenicurus*) for the

[1] The genera *Doto*, *Platydoris*, *Discodoris*, *Marionia*, and many others are in this case.

Nudibranch *Tethys*, which is put into practice by several important authors, chiefly American. The ordinary European use of *Aplysia* (for a Tectibranch) and *Tethys* (for a Nudibranch) creates no confusion or inconvenience. The only objection to it is that it rests on the authority of the twelfth edition of Linnæus's 'Systema Naturæ,' whereas the tenth edition has been accepted as the standard authority for nomenclature. But is it worth while to upset for a mere question of bibliography well-known names of common animals used in hundreds of zoological works?

Those changes of nomenclature which depend on a change in the extent assigned to genera or species are inevitable, for they represent a change in zoological ideas. They are nevertheless very confusing. Alder and Hancock's use of generic names in the first six parts of the Monograph (corrected to some extent in the seventh part) is too wide. For instance, *Doris tuberculata* and *Doris bilamellata*, now brought under different families, cannot be included in one genus. But the multiplication of genera by later authorities, such as Bergh and Trinchese, seems to go too far in the opposite direction. If forms distinguished by only minute differences (such as *Cuthona*, *Cuthonella* and *Cratena*) are given a generic rank nominally equivalent to that of *Æolidia*, *Facelina* and *Coryphella*, the balance of classification is upset, and the fact that certain types present numerous varieties divided by small distinctions is obscured. Incongruous results also arise from the failure to apply the same principles of sub-division impartially. Thus, some Dorids (*Diaulula* and *Gargamella*) are put into separate genera merely on account of the presence or absence of an armature on the genitalia. Yet it is admitted that this armature may be present or absent in the same species, *Acanthodoris pilosa*. *Cadlina* is made the type of a sub-family because it has a central tooth in the radula, but *Chromodoris scabriuscula*, which has a central tooth and other anomalous features, is not removed from the genus *Chromodoris*. Some genera have an unnaturally narrow definition; others (*e. g. Thordisa*) acquire an inconveniently wide one, as various forms for which there is no better place are assigned to them. The classification of the Nudibranchiata will, I feel sure, be improved when many of the existing genera are amalgamated, but the thorough-going application of such a principle will be profitable only when the list of animals to be classified is much fuller than at present, for we still know little about the Nudibranchiata of the tropical Atlantic, the west coast of South America, and the southern temperate seas.

In the present work, however, I have proposed some changes which seem justified by available data. I do not think that it is either correct or convenient to abolish the generic name *Doris*, first used by Linnæus and adopted by many eminent naturalists, including Alder and Hancock. If *Staurodoris verrucosa* is equivalent to *Doris verrucosa* L., then, according to the rules of nomenclature, this latter name must be used, and a large genus (comprising *Archidoris* Bergh, *Homoiodoris* Bergh, *Staurodoris* Bergh, and others) is both convenient and scientifically sound. The question is treated in more detail below. Similarly, the distinctions drawn between *Cuthona*, *Cuthonella* and *Cratena* seem to me to be of less than generic value, and if the three are united in one genus it must by the law of priority be called *Cuthona*. Again, *Æolidiella*, *Spurilla* and *Berghia* differ only in the surface of the rhinophores. These organs show a complete series of gradations from a smooth to a perfoliate or tuberculate surface, and there is no point in the series which can be fixed as a generic division, for the rhinophores of *Æolidiella* are not always

smooth (as the definition of the genus implies), but in some species exhibit furrows or rudimentary perfoliations. All three genera should therefore be included in the earliest, viz. *Æolidiella*. In the Ascoglossa the distinctions between *Hermæa*, *Hermæina* and *Placida*,[1] and between *Stiliger* and *Ercolania* are at most of sub-generic value. Sub-genera are useful in the classification of the Nudibranchiata, for in many cases the special student finds it convenient to divide a numerous group into sections, while for general zoology it is more important to remember that it is an aggregate of similar forms.

The following points of nomenclature may also be noticed:

In *Dendronotus* the specific name *frondosus* of Ascanius must unfortunately be substituted for the accepted but later *arborescens* of Müller.

Hancockia Gosse, 1877, is a valid name, and there is no reason why it should yield to *Govia* Trinchese, 1886.

Cumanotus Odhner is here accepted as the proper genus for *Coryphella beaumonti*. Of *Coryphella pellucida*, *C. gracilis* and *C. smaragdina*, the last two are colour varieties, and in the opinion of some authorities all three are varieties of *C. rufibranchialis*.

Calma is a valid genus, but its characters have been somewhat misunderstood. It should include *Calma* A. & H. and *Forestia* Trinchese, but exclude *Calma cavolini* Vérany.

The names *Antiopa* and *Janus* are both preoccupied, and the genus should bear the name *Antiopella* (1902) proposed by Hoyle. But *A. hyalina* is referred by Bergh to *Janolus* (1884). The original definition of this genus has been considerably relaxed by Bergh, and it may be questioned if it should not be further extended so as to include *Antiopella*. The two genera are distinguished only by the jaws.

Galvina tricolor probably includes as varieties *E. farrani* A. & H., *E. amethystina* A. & H., and *E. adelaidæ* Thomps. *Amphorina cærulea* includes *A. molios* (Herdm.).

Stiliger bellulus has priority over *St. mariæ* as the name for the British species of this genus.

The genera *Acteonia* A. & H. and *Cenia* A. & H. were subsequently amalgamated by Alder, but had better be kept separate provisionally as the development of *Acteonia* is not known. The development of *Cenia* is unusual; that of the allied *Limapontia* follows the normal course.

The evidence of the type specimens indicates that *D. testudinaria* and *D. planata* are separate forms and referable to the genera *Doris* and *Geitodoris* respectively. But the second form lies under suspicion of being immature, and it is conceivable that the buccal parts may vary in different individuals and in different stages of growth.

The perplexing *Doris millegrana* A. & H., which appears from an examination of the type specimens to be the animal described by Bergh as *Thordisa ? dubia*, is here referred provisionally to von Jhering's genus *Aporodoris*. Whether that genus will really prove valid when various allied forms are better known is another matter.

[1] There is some doubt as to the characters of *Hermæopsis*.

IV.

BIONOMICS.

Most Nudibranchs lead tranquil and sedentary lives occupied in growth, nutrition, pairing, and egg-laying, after which they are believed to die. Vigorous movement, such as fighting or the pursuit of active prey, is comparatively rare, and no forms are known to build homes or nests, though their eggs are protected by various envelopes and arranged in coils or ribbons on suitable spots.

The duration of life is probably about a year. In England the animals are generally hatched in the spring or summer. Growth is rapid, and a microscopic veliger can attain its full size as an animal two or three inches long in less than twelve months. After a brief period of spawning it is probable that death supervenes. The evidence on this point is not entirely conclusive, but there is no record of animals living in captivity for more than a year: they certainly often die soon after spawning, and dead specimens are often found on the shore in the summer months. On the other hand captivity is likely to shorten life; some species which are known to attain a considerable size begin to spawn when they are relatively small; and some species (*e. g. Doris verrucosa*, according to Mazzarelli's observations at Naples) spawn throughout the year. But it is not likely that the duration of life is considerable in any case.

All known Nudibranchiata are marine, with the one exception of *Ancylodoris*, found in Lake Baikal. This lake was no doubt once in connection with the ocean, and contains other indications of an originally marine fauna, but *Ancylodoris* appears to have departed in some respects from the usual Nudibranchiate type. A few forms, especially in the Limapontiidæ, frequent brackish estuaries and possess to a limited extent the power and the habit of quitting the water.[1] *Doriopsilla areolata* is also said to live in tidal pools and to sun itself. It is remarkable that the Nudibranchiata (like the Echinodermata, Polychæts, and Brachiopods) should be unable to support life except in salt water, but it seems to be a fact that fresh-water molluscs offer no instances of the shell disappearing or becoming internal. The main difficulty which life in fresh water offers to Nudibranchs as well as to Echinoderms, etc., is that the delicate free-swimming larva does not find the food and other conditions necessary to its existence. In this connection it is interesting to observe that *Cenia*, which frequents brackish water, has an abnormal larval development, which takes place within the egg. But even for adults migration from the sea to rivers would present many dangers and hardships. Soft, slow-moving marine animals, conspicuous if taken out of their usual surroundings, and mostly carnivorous, would be more exposed to their enemies in streams and lakes, and less able to find their prey. But these considerations do not altogether explain why it is that molluscs which have successfully adapted themselves to life in fresh water do not show the tendency to reject or reduce the shell visible in both marine and terrestrial gastropods.

[1] *E. g. Alderia* and *Cenia*.

The principal movements of Nudibranchs consist of creeping and floating. The former action is performed as in other Gastropods by secreting a layer of mucus along which the animal slowly slides by expanding and contracting different portions of its pedal disc. As might be expected from their build, the Cladohepatica and Polyceridæ are much more agile than the Doridida. This is partly due to the fact that the Doridida feed chiefly on sponges and live literally on or partly embedded in their prey. The majority of Æolids on the other hand eat small Hydroids which require a relatively active search. Some Dorids, especially the stiff tropical forms with wide mantle-margins and small feet (*e. g. Platydoris scabra*), remain in one place until their shape comes to fit into their surroundings. Among the Cladohepatica the elongate forms such as *Facelina*, *Coryphella* and *Bornella* are specially active. When kept in confinement they often eat one another's cerata and appear to fight.

Like many other Gastropods (*e. g. Skenea* and *Rissoa*), Nudibranchs can float with the ventral surface uppermost, and in confinement many of them show a great love of this position. It is doubtless facilitated by the lightness of their weight compared to their size.[1] As far as is known, they are obliged to make their first excursion to the surface with the aid of a piece of seaweed or other material support, and possess no power of levitation of their own. On reaching the surface they secrete from the foot a layer of mucus and remain in an inverted position with the dorsal region downwards and the foot and mucus-layer upwards. By bringing the margins of the foot together they can drop from this position at will, and they frequently remain suspended some inches below the surface by a thread of mucus connected with the superficial layer.[2] Having once established communication with the surface by means of this thread they are able to climb up it again at will. A few Nudibranchs have become definitely pelagic (*Phylliroe*, *Glaucus*) and many others partially so, frequenting seaweed or floating objects (so *Scyllæa*, *Fiona*, and several forms from the Sargasso Sea).

Some Nudibranchs which are provided with wing-like expansions at the side or with flat tails have some power of swimming, such as *Elysia*, *Hexabranchus*, and especially *Plocamopherus*. Even clumsy-looking Dorids may exhibit unexpected powers of movement in special circumstances, and when dropped into a few feet of water will find their way to the bottom with movements like those of a flat fish.[3] As mentioned above both adult and young Nudibranchs appear and disappear suddenly in considerable quantities, especially before spawning and after hatching. Alder and Hancock were disposed to disbelieve in these migrations, but there is a good deal of evidence for their occurrence. It is not known how they are performed, but as creeping is an extremely slow process, it is possible that the animals make use of currents in which they suspend themselves as described. But though creeping Nudibranchs are quite at home on or under the surface of the water when they once reach it, it must be remembered that we have no evidence of their power to rise by their own efforts.

The Doridida subsist chiefly on sponges, Bryozoa, and compound Ascidians; *Tritonia*

[1] According to Hecht an *Æolidia* 6 centimetres long weighs only 12 grammes.

[2] See N. Colgan in Ann. and Mag. N. H., ser. 8, vol. iii, April, 1909, pp. 354—362, "On Locomotion and Use of Slime-threads in Marine Mollusca."

[3] I have observed this specially in the large East African Dorid *Thordisa crosslandi*.

on *Alcyonium*; Æolids on Hydroids, *Actinia*, and sometimes on small molluscs; the Ascoglossa on the juices of seaweeds. Though our information as to feeding-habits is not so full as it might be, it seems clear that the various types of buccal parts are adapted to the various kinds of food, and this is confirmed by the fact that an unusual structure of these organs is often associated with an unusual diet.[1] Thus Dorids have no true mandibles (though the labial cuticle is sometimes strengthened by a chitinous armature) but a broad radula. This apparatus is clearly suited to eating a stationary object which does not need to be captured, and offers no projections to be bitten off, but does require to be torn to shreds previous to digestion. This function is discharged by the broad radula which (as shown by the contents of the stomach of *D. tuberculata*) converts a piece of sponge into fragments varying from 0·5 mm. to 1·5 mm. in length. As the mouth of *Doris* when eating is always hidden by the folds of the foot and mantle, it is impossible to say how it detaches morsels from the surface of the sponge. It may be that it everts the radula[2] until it is able to scrape the surface of the whole mass; or it may be that by suction it is able to draw a portion of sponge into the buccal cavity and triturate it there. Some species of the genus *Doridopsis* (which has no radula at all) eat compound Ascidians, and this seems to show that a Nudibranch has no difficulty in drawing up into its mouth portions of a relatively soft substance. Nearly all the Cladohepatica[3] have mandibles with cutting edges which act like a pair of shears. *Tritonia* has likewise a wide radula, which is natural, since its food, *Alcyonium*, is spiculous like the sponges eaten by *Doris*. A chunk is cut out by the mandibles and then torn to pieces on the radula. But the prey of the Æolids is small and soft. After a piece has been nipped off by the mandibles a single row of teeth furnished with denticles is sufficient to prepare it for digestion. The Ascoglossa have no jaws but a special type of radula (in which only a few teeth, sometimes not more than three to four, are in action at the same time) and sometimes a special pouch termed *ingluvies buccalis* attached to the buccal mass. Some species (perhaps most[4]) feed by scratching the surface of seaweeds and sucking the juice up into the *ingluvies buccalis*[5] so that the radula is not a masticatory but a penetrating organ capable of breaking up cells and setting their liquid contents free. The muscular walls of the *ingluvies* then contract and force the fluid into the narrow and complicated canals which form the digestive system. Very exceptional are the feeding habits of *Melibe* and probably also of *Tethys*, an allied European form which I have not had the same opportunities of studying. *Melibe* has no radula and only feeble jaws, but its mouth is surrounded externally with a large funnel which may be more than an inch deep. The margin is contractile and furnished with long cirri, so that it can either form a wide-open expansion or contract to a small opening which can be closed by the cirri. In its expanded state this funnel is used as a net, with which the *Melibe* sweeps the surface of stones, capturing small

[1] *E. g.* in *Calma glaucoides*, which feeds on fish eggs, and *Melibe*, which captures Crustacea.

[2] This of course assumes that the radula can be advanced greatly in front of the position which it usually occupies. But this is not improbable. The genitalia can be extended to a very great extent in copulation and oviposition, and the mouth parts may have the same power.

[3] The only exceptions are the Ascoglossa, *Tethys*, and the ambiguous *Hedyle*.

[4] See Brüel 1, p. 88, ft.

[5] I have never been able to discover how the *ingluvies buccalis* and peculiar radula act in *Acanthodoris*, *Lamellidoris*, *Goniodoris*, etc.

crustaceans and even those of relatively considerable size. When any are secured it tosses the funnel upwards, the margin contracts and the cirri close the opening over the prey, which is drawn down the short œsophagus into the stomach. Here its hard integuments are broken up by a girdle of stomach plates. No other Nudibranch is known to show such an appearance of design in hunting, but *Facelina coronata* is very voracious and devours *Elysia viridis* as well as small Æolids, including its own species. *Æolidia papillosa* attacks and eats sea-anemones,[1] a task which demands immunity to their stinging cells rather than agility. It usually gnaws the base or column and leaves the tentacles alone.

The Mollusca are essentially soft animals. None of them, with the exception of the Cephalopods, are well equipped for a combat or capable of rapid movement. They can, in fact, neither fight nor run away. It is therefore natural to find that in most families they are protected by a strong shell, safe within which they are not exposed to a higher percentage of accidents than other marine creatures. We might expect the shell to be indispensable, but it clearly is not, and some members of most groups and nearly all the Opisthobranchiata show a decided tendency to reduce its dimensions or get rid of it altogether. It is not surprising if this loss of armour is compensated by other methods of defence manifested both in habits and structure. Soft flexible animals can burrow in mud or sand and frequent the under-side of stones or thick tufts of seaweed more easily than those protected by heavy shells. Their mobile and often pellucid integuments are peculiarly susceptible of changes in shape and colour. This leads to frequent cases of protective resemblance, that is to say, Nudibranchs escape notice because their colour and to some extent their shape fit in with their surroundings. Of the reality of this phenomenon no one can doubt who has collected them in the tropics. Dorids several inches long remain invisible on the surface of a stone surrounded by seaweed, and are detected only by touch. Brilliantly red and yellow species frequent Ascidians and sponges of the same colour, among which they attract no notice. Similarly, among British species the two red Dorids *Rostanga coccinea* and *Doris flammea* live on red sponges (the former on *Microciona atrasanguinea*), and *Jorunna johnstoni* can hardly be detected on *Halichondria panicea*, where it is usually found. *Calma glaucoides* eludes observation among the eggs of fish, which it eats, and many forms bearing prominences or branched processes, such as *Ægires*, *Doto* and *Dendronotus*, have been noticed to correspond exactly in colour with the Bryozoa or Algæ, which form their usual habitat. *Hermæa bifida* is an interesting example of such correspondence. It lives on red seaweeds of the genus *Griffithsia*, with which the general outline of its body does not harmonize. But in the water this outline is indefinite; the integuments and most of the organs are transparent and colourless, so that the only conspicuous features are the red hepatic canals in the body and their red diverticula in the cerata. These exactly imitate the fine branches of the seaweed in form and colour, the latter indeed being transferred from the plant to the animal which sucks its juices.

These resemblances are striking and clearly cannot be disadvantageous to the molluscs, but still I think that much of the language used about protective coloration, as if the animals were made to look like their surroundings by some special power either in themselves or

[1] Chiefly *Actinia* and *Anthea*. It seems to be afraid of *Tealia*.

external, is too anthropomorphic. It under-estimates the importance of one commonplace factor in the situation, namely, that the two objects which resemble one another (such as the Nudibranch and the sponge or seaweed) have been associated and exposed to the same influences for unnumbered ages. Thus, whatever may be the causes which tend to give a sponge a certain appearance, they must also affect the Dorid which lives on the sponge, at least so far as they are external and concerned with water, temperature, and general surroundings.[1] The Dorid eats the sponge, and though its colour is not affected by its food so directly as in Æolids, yet there is a connection between the two, and Dorids deprived of food lose their colour. Further, though a Dorid is very different from a sponge in general structure, it does resemble it in some details; the integuments are spiculous, the back is often marked with little pits, and there are three openings for the two rhinophores and the gills, which resemble the oscula of the sponge. Thus the Dorid, which is comparatively stationary for the greater part of its life, lives among the same conditions as the sponge, eats the sponge, and shows in the part of it which is visible much the same structure as the sponge. That the two should become alike is not surprising, and it is probable that Dorids becoming conspicuously unlike the supporting sponge would be picked off and eaten by passing fishes. More difficult to explain are the cases where a Nudibranch is coloured, not like the seaweed or sponge which it habitually frequents and eats, but like its apparently chance surroundings, such as a piece of rock covered with nullipores and tubes of *Spirorbis*. But varieties of *Doris tuberculata* have been recorded to simulate perfectly the colour of such an environment.

Other interesting cases of resemblance are afforded by the convergence in appearance which sometimes takes place between Nudibranchs and other groups. Certain species of *Psolus* (Holothurioidea) are so like Dorids, and certain Turbellarians (especially Polyclads with tentacles) are so like the Elysiidæ, that careful examination is necessary to distinguish them, although in general organization the animals are very different. Less complete but still striking is the resemblance borne by many Æolids, when slightly contracted, to sea-anemones.[2] Within the limits of the Mollusca may be noticed the general superficial resemblance between Lamellariidæ, Pleurobranchidæ, Oncidiidæ, and Dorids. I have often mistaken the living *Oncidium savignyi* for a Dorid, for though it has a respiratory chamber as usual in the genus, the processes on the back become elongate and somewhat contractile just at the point where a Dorid would have gills. Some Polycerids, such as *Triopa clavigera*, appear to mimic Æolids, such as *Galvina farrani*.[3]

In some of these cases the mimicking form may gain some advantage by resemblance

[1] It may be noted that not only do Dorids resemble sponges (where the resemblance is advantageous to the Dorids) but also sponges resemble Dorids (where no such advantage to the sponge is clear). I have often noticed this in small living tropical sponges, and an excellent illustration of it will be found in the sponge figured in Delage and Hérouard's 'Zoologie Concrète,' vol. ii, Pt. i, Pl. 12, figs. 1 and 2.

[2] *E. g. Æolidia papillosa* to *Sagartia troglodytes*; *Æolidiella alderi* to *Sagartia sp.*; *Berghia cœrulescens* to *Aiptasia lacerata*.

[3] See Hecht **1**, p. 577. As far as can be judged from preserved specimens, the Californian Polycerid *Laila cockerelli* must be strikingly like an Æolis.

to a distasteful animal. Æolids appear to be disliked by fishes, and perhaps the brilliantly coloured Polyclads have a similar immunity, whereas *Elysia* is known to be eaten by other animals. But in the other cases it is not clear that either party gains any advantage from the resemblance, and the shape may be due to mechanical reasons. A consideration of *Lamellaria*, *Pleurobranchus*, *Doris* and *Oncidium* suggests that Gastropods of very different types tend, when their shell becomes internal or is lost, to assume the same oval flattish shape, especially if they are sedentary. The general conditions of marine life probably make it natural that a mass of soft flesh adhering by its base, not moving much and in any case making no attempt to swim, should assume this form. More elongate and active animals such as Æolids, Polyceridæ, Ascoglossa and Acclesia show a tendency to develop processes and branches which is almost entirely absent in the squat oval forms. Similarly there is a marked tendency illustrated in the most divergent groups (Cœlenterates, Holothurians, Cephalopods, worms, etc.) for the body to assume an oblong form with a tuft of processes at the end. This shape, unknown among land animals, clearly responds to the conditions of marine life. Dorids habitually have their branchiæ disposed in a tuft which is terminal as far as their shape permits, and *Oncidium* shows a tendency towards this arrangement. Now *Psolus* is a specialized form which differs from other Holothurians in having a clearly differentiated creeping surface. The possession of this sole makes it for locomotive purposes a machine similar to *Doris*. The mouth and the circle of tentacles surrounding it cannot collect food conveniently in a ventral position,[1] and hence move up to the dorsal region where they assume very much the position and appearance of the branchial rosette of *Doris*. *Elysia* and the Polyclads are both animals of somewhat unusual structure, namely a thin but fairly broad sheet of flesh which can both crawl and swim. It is not perhaps surprising that similarity of appearance should result from this similarity of movement and external plan, although the internal differences of structure are so great.

Some Nudibranchs which are distasteful to fishes (and probably to other creatures) as articles of food appear to be defended by a warning coloration. Prof. Herdman[2] made a series of experiments which pointed to the conclusion that among common British Nudibranchs the order of edibility is *Dendronotus*, *Doris*, *Ancula*, and Æolids, the Æolids being the most distasteful form. Mr. Crossland also informs me that the fish of the Red Sea reject blue Chromodorids. There can be no doubt that many brightly coloured animals (such as *Ancula* and *Chromodoris*) display themselves in a way which argues immunity, but it is also true that they often live among equally brightly coloured Ascidians and sponges, where, if not invisible, they at least attract no attention. But it is difficult to attribute any special aim, either attractive or warning, to the beautiful colours of Nudibranchs, because a large number of the most brilliant forms frequent localities like the underside of stones, where they must be invisible to friend and foe alike. Their own sight cannot do more than distinguish light and darkness, so they cannot please one another by their beauty. Also one form, *Hexabranchus*, seems to be both protectively

[1] It would seem that *Psolus*, like *Cucumaria*, does not dig in the sand, but holds up a tuft of tentacles, which it from time to time retracts, together with the small animals it may have collected in them.

[2] Third Report on the Nudibranchiata of the L.M.B.C. District, 1890.

and warningly coloured in different attitudes. It is one of the largest and most active of tropical Nudibranchs, having a broad, bright red mantle-margin, and in the centre of the back an area coloured by various shades of yellow. When it displays the margin it is exceedingly conspicuous. When it folds over the flexible red margin and exposes only the yellow back, it is hardly visible on a sandy bottom.

The distastefulness of some Nudibranchs perhaps depends on their power of secreting mucus. Many species can pour forth this secretion in abundance sufficient not merely to render them unpalatable but to entangle and hamper a small animal with appendages, such as a crustacean or worm. Several forms, such as *Doto*, *Calma glaucoides*, *Proctonotus mucroniferus* and *Elysia viridis* have special glands, which appear to discharge an offensive secretion, and this is probably the function of the glands found on the branchiæ of many Dorids.[1] They disgust inquisitive enemies who may be disposed to nibble these delicate organs. But by far the most effective and remarkable arms of defence are the nematocysts found in many Cladohepatica,[2] and the proof of their origin, due to Mr. Grosvenor[3] and Professor Cuénot, is the most important contribution to the biology of the group made since the time of Alder and Hancock. In most Æolids there is present in the tips of the cerata a sac of endodermic origin, which communicates directly with the exterior, and also, by means of a ciliated canal, with the diverticula of the liver which form the core of the cerata. This cnidosac, as it is called, usually contains nematocysts or thread-cells. These are minute capsules containing a fluid in which is coiled a long thread. Under a suitable stimulus they pass out of the cnidosac into the water, evert the thread, and are capable of stinging any delicate animal. It had long been known that the nematocysts of Æolids are similar to those of various Cœlenterata (*Actiniæ*, *Tubulariæ*, etc.) on which they feed, and as early as 1858 Strethill Wright maintained that they passed into the molluscs from their prey, but for a long while the explanation was thought too extraordinary to be credible, and the nematocysts of the Æolid were supposed to be developed within its own cnidosacs. But thanks to the researches mentioned it may be considered proved that they are not produced from the tissues of the Æolid, but are acquired by it from Cœlenterata in the process of feeding, and pass through the stomach and hepatic diverticula into the cnidosacs without being digested. That such a passage is possible is shown by the fact that other indigestible matter, such as the radulæ of small molluscs, has been observed in the cerata of Æolids. Such strange phenomena require the confirmation of careful observation and experiment, but the evidence is clear. (1) Nematocysts are of many distinct kinds. Several kinds may occur in one Æolid, and individuals of the same species may have different kinds of nematocysts. (2) It is shown by experiment that the cnidosacs always contain nematocysts similar to those of the Cœlenterate on which the Æolid has been recently feeding, and that the nematocysts found in the hepatic diverticula and fæces are similar. (3) The nematocysts of an Æolid can be changed by changing its food, and those Æolids which habitually feed on animals

[1] See Hecht **1**, pp. 596—604.

[2] In most Æolids, and in nearly all Pleurophyllidiidæ.

[3] See Grosvenor, "On the Nematocysts of Æolids," Proc. Roy. Soc., 1903, pp. 462—486. Glaser, "Nematocysts of Nudib. Moll.," J. Hopkins Univ. Circ., xxii, p. 22, 1903. Cuénot, "L'origine des nématocystes des Eolidiens," Arch. de Zool. expér., 1907, pp. 73—102.

which have no nematocysts have none themselves.[1] But the phenomenon, though so clearly attested, remains extraordinary and, indeed, unique. The nearest parallel is the behaviour of the Cephalopod *Tremoctopus microstoma*, which is said to carry on its arms fragments of a stinging medusa. But there is no real analogy for the functions here assumed by the alimentary canal, which accepts substances not in order to digest or take them into the system but in order to eject them by special orifices as a means of defence. Very unusual too is the plan of the alimentary system, which communicates with the exterior not merely by the mouth and anus but by numerous orifices, in some cases hundreds.[2] It does not appear that an Æolid uses its nematocysts for paralyzing its prey or that it discharges them against advancing enemies. When attacked it contracts its body, at the same time erecting and sometimes lengthening its cerata, so that the assailant can hardly help touching them. When bitten or squeezed they pour forth the stinging nematocysts; the assailant probably withdraws and the Æolid probably escapes with the loss of some of its cerata, which seems to be no inconvenience. Most (though not all) fish reject Æolids, but it is not certain whether the mucus or the stinging is the more distasteful feature. It seems that those Æolids which have no nematocysts, such as *Calma* and *Fiona*, have specially abundant mucus or offensive glands.[3]

It is clearly to the advantage of Æolids and other animals of a similar structure that the cerata should not be vital parts and should be detachable without serious injury, for unless the animal is swallowed whole these are the parts which an adversary is bound to seize at the first attack. Accordingly we find that in most (probably all) Æolids the cerata can be torn off by slight violence, and in some detach themselves spontaneously when the animal is annoyed. Among British species this autotomy is common in *Tergipes despectus*, *Galvina exigua*, *Doto* and *Antiopella*. The last named, which in its normal condition has numerous large cerata, is sometimes found covered with minute ones and presenting a totally different appearance. These are young cerata in course of regeneration replacing those which have been thrown off. In *Proctonotus* the cerata are not only easily detachable but have a special apparatus at the top which enables them to adhere to extraneous objects. They are also richly provided with glands, and thus when an enemy seizes them they adhere and annoy him with their secretion while the body of the *Proctonotus* crawls away. Similar autotomy is not recorded of any British Dorid, but in the tropics *Discodoris fragilis* and others are capable of casting off the whole mantle-margin and remain in apparent good health.

The Nudibranchiata, like most marine animals, are infested by both external and internal parasites. Though these unbidden guests attain a relatively considerable size, they do not appear to injure their hosts as a rule, for they attain maturity in full-

[1] Many other confirmatory details and experiments are given by Cuénot and Grosvenor (*l. c.*). It is a pity that all the observations were made on Æolids and did not include the very differently shaped Pleurophyllidiidæ, which also have nematocysts.

[2] A somewhat similar arrangement occurs in some Turbellaria such as *Yungia* and *Cycloporus*. In these animals the digestive cavity exhibits numerous branched diverticula which extend to the integuments and communicate with the exterior by terminal openings. In *Cycloporus* these openings are said to occur close together around the entire margin of the body.

[3] So, too, *Hermæa* and *Proctonotus*.

grown specimens. The commonest parasites of both classes are Copepods. The family Ergasilidæ furnishes ectoparasites which run about on the branchiæ of Dorids and cerata of Æolids. Most authors refer them to the genus *Lichomolgus*, but some cite two genera, *Doridicola* and *Eolidicola*. Hecht[1] states that *Lichomolgus doridicola* is found indifferently on *Doris tuberculata*, *Jorunna johnstoni*, *Triopa clavigera*, *Æolidia papillosa*, *Facelina coronata*, *Antiopella cristata* and *Proctonotus mucroniferus*, varying in coloration according to its host. Infusoria of the genus *Licnophora* also frequent both Dorids and Æolids. A Pycnogonid, *Nymphon parasiticum*, is parasitic on *Tethys fimbriata*.

The commonest internal parasites are also Copepods of the family Chondracanthidæ. The genus *Splanchnotrophus* Hancock is represented by five species found in British Nudibranchs, both Dorids and Æolids. The body of the *Splanchnotrophus* is concealed within its host (usually in the general body-cavity near the heart), but the two terminal egg-sacs project externally. They are often not noticeable among the dorsal appendages, but are sometimes conspicuous, as in *Lomanotus genei*, which appears much exposed to the attacks of a large *Splanchnotrophus*.[2] Less common internal parasites are Cestodes (*Tetrarhynchus* sp.), Trematodes (*Distomum glauci*), and Nematode worms. The last-named, though apparently not recorded from British Nudibranchs, are sometimes found in enormous quantities in tropical forms. Vegetable parasites are rare. The buccal organs and anterior part of the body have been occasionally found to be invaded by vegetable growths described as Phycomycetes, and the presence of symbiotic algæ in the dorsal integuments has been suspected but not conclusively proved.[3]

The Nudibranchiata do not create an impression of intelligence, and in this they resemble most Mollusca, except the Cephalopods. We are perhaps apt to connect intelligence with limbs; anything that grasps and reminds us of a hand suggests volition and purpose. But the slimy sluggish proceedings of these legless and handless beasts seem to be little more than vegetative. When a crab such as *Inachus* or *Hyas* plants sea-weeds and zoophytes on its back, it seems to show extraordinary intelligence or instinct. But when an Æolid utilizes foreign bodies for defence by eating an Actinia and turning its stinging cells into ammunition, this seems a physiological process, strange indeed, but as independent of volition as is digestion. But probably the difference in intelligence between the acts of the crab and of the Æolid is not great. It is remarkable that such delicate and apparently defenceless animals as the Nudibranchs do not make burrows or tubes like those of Annelids. The explanation must be that thanks to mucus, nematocysts, and the other means described above, they are much better defended than we think. The only recorded attempt to make a lodging for themselves is the habit of some forms (especially *Idalia*) of eating into the substance of Ascidians and sponges until their gluttony affords them a shelter. But this form of residence cannot be given a high place in the annals of marine architecture.

[1] Nearly allied are the two genera *Ismailia* and *Briarella* of Bergh, recorded from exotic Nudibranchs.

[2] Probably *Spl. insolens* Scott. In a tropical Dorid 30 mm. long I have found a *Splanchnotrophus* (or species of an allied genus) 10 mm. long, that is, one third the size of its host.

[3] In *Doridoeides* by Eliot and Evans, and in *Melibe* by Hornell.

The most important sense-organs of Nudibranchs are probably the rhinophores or dorsal tentacles, which are not only olfactory in the strict sense but enable the animal to test the quality of water and detect the presence of anything undesirable. They seem to be aware of the presence of one another or of suitable food at a considerable distance, and probably this information comes from the rhinophores.[1] The eyes can hardly do more than distinguish light and darkness, for though they are usually well developed they are always covered by the dorsal skin. The sense of touch extends to the whole of the integuments, but is specially delicate in the oral tentacles and branchiæ. In some tropical Dorids these latter are sensitive to light and will contract if a shadow falls on them. I have not found this to occur in British forms, but their branchiæ are very sensitive not only to touch but to any movement of the water. Otoliths (or otoconia) are always present in the central nervous system, but their precise functions are not certain.

The most complicated, if not the most intelligent acts of Nudibranchs, as of most invertebrates, are concerned with depositing their eggs. The precautions taken to protect or even to hide their eggs are not elaborate, and the propagation of the species is ensured chiefly by the enormous number produced. It has been calculated that the nidamental ribbon of Doris may contain 600,000. Sometimes the strings or ribbons containing the eggs are left in conspicuous positions; sometimes they are placed in surroundings where they are not noticeable, or in sheltered nooks, such as the under side of rocky ledges. But in all cases the eggs are enclosed in some kind of case.

At certain times of the year Nudibranchs resort to the coast in order to pair, and they probably take little nourishment at this season. In the period immediately before spawning the stomach is found to be empty, and the genitalia, especially the mucus and albumen glands, swell to such a size that they compress the alimentary tract against the dorsal integuments. Some details as to the act of pairing are given by Hecht.[2] It is reciprocal, and though hermaphrodite Mollusca are incapable of self-impregnation both individuals spawn after mating. But some species (*e. g. Doris tuberculata*) pair more than once before both spawn, at any rate in captivity. The equivalent of a nest is provided by transparent membranes of various shapes in which the eggs are enclosed. The simplest form of egg-case is a rounded capsule such as that laid by the Limapontiidæ. Not much more elaborate are the oval masses of bright white which *Galvina exigua* hangs on seaweed, and the kidney-shaped capsules of *Tergipes despectus*. Many small Æolids, such as *Amphorina aurantiaca* and *A. olivacea*, deposit spawn in a single imperfect coil, generally resembling a roughly drawn crescent, and the spawn of some Polycerids, such as *Polycera quadrilineata* and *Ancula cristata*, is much the same. But other genera, both of Æolids and Dorids, produce more complicated patterns. In structure the spawn may be either a simple string, or a ribbon with eggs evenly distributed, or a ribbon with the eggs

[1] One would be inclined to think that the efficiency of the rhinophores was due to the delicate perfoliations with which they are often covered. But among the Æolids genera whose rhinophores are smooth (*e.g. Coryphella*) seem in no respect inferior to their relatives who have them perfoliate (*e.g. Facelina*).

[2] Hecht **1**, pp. 678—681. All observers agree that the genitalia are greatly extruded in copulation, so that the spermatotheca may act as a bursa copulatrix, difficult as this is to believe when it is in its normal position.

collected in a line along one margin, which may also be described as a string attached to its support by a membrane along its whole length. In arrangement the string or ribbon may be hung in an irregular festoon on seaweed, or arranged on a flat surface, sometimes in the shape of a cup with the margin turned outwards (*Acanthodoris pilosa*), or more frequently in a spiral of varying completeness and complexity. *Lamellidoris bilamellata* lays a short spiral of one or at most two coils; *Doris tuberculata* a large triple coil, which may be as much as fifteen inches long when extended; *Jorunna johnstoni* a spiral of four coils with elegantly scalloped margins; *L. inconspicua* and *L. depressa* simple but extensive spirals of seven to ten whorls. But the spawn of many Æolids (*Coryphella*, *Facelina*, *Æolidia*; also *Antiopella*) is not only arranged in a spiral but the ribbon or string is itself zig-zagged in its spiral course. *Cumanotus* suspends a single cork-screw-shaped coil by a long thread. The forms of spawn are, in fact, so distinctive that the eggs of each species can usually be identified, and genera and families are to a certain extent characterized by the use of a particular arrangement or pattern. But generalization in this respect is not very safe since widely different animals may agree in laying a single coil, and kindred species (*Lamellidoris bilamellata* and *L. depressa*) may show very different degrees of elaboration in their work. But, for mechanical reasons it would seem that Dorids with wide mantle-margins are best adapted to produce broad flat ribbons, because the flat shape is maintained by compressing the mass of egg-jelly between the foot and mantle, and the undulation of the edges, when it exists, is the counterpart of the undulations of the mantle-margin. On the other hand small animals without any mantle, such as the Limapontiidæ, merely deposit short capsules. The composition of the ribbon is often complicated, and it usually consists of at least two layers: (1) A general envelope enclosing all the eggs; (2) one or more envelopes enclosing groups of eggs in strings or patterns. To these may be added the attachment jelly which fixes the whole structure on its support.

The formation of the ribbon in *Doris tuberculata* has been studied by M. Bolot. It takes place within the large organs known by the names of albumen and mucus gland. The fertilized ova enter a canal in the centre of the first gland and receive a coating of albumen poured on them from its walls, which are formed of ramified tubes. They then go through narrow passages, where they receive a second envelope, which forms the egg-shell.[1] Both these operations take place in the more opaque portion of the gland. The eggs then traverse the twisted semi-transparent tubes which form the outer portion of the gland and emerge embedded in a long string of jelly. This string falls into the central cavity of the gland, where it is compressed by the flat walls and receives a final layer of mucus, which constitutes the ribbon. Thus within the ribbon lies the much twisted egg-string, and within that again the ova in a double envelope.[2] As the ribbon issues it is soft and adhesive, but soon hardens in the water. The Doris attaches one end to a suitable spot and then begins to move slowly, thus aiding the exit of the ribbon by pulling against the fixed point. But the exit is also due to an extrusive movement in the glands,

[1] This, of course, has nothing to do with the shell of the larva, which is secreted by a gland formed in the larva itself.

[2] Bolot, "Sur la ponte des Doris," Comptes rendus de l'Acad. des Sciences, Paris, 1886, p. 829.

which can be seen externally in a pulsating vesicle[1] at the opening of the oviduct, which partly surrounds the ribbon and throbs rhythmically as it slowly pays it out. In *Doris tuberculata* the rate of spawning is a little more than half an inch an hour.[2] The ribbon passes backwards on the right side of the animal between the mantle and the foot, and thus receives a curve along the whole of its length, the concave side facing outwards. The edge which lies nearest to the foot is attached to the rock, and the curl of the spiral is counter-clockwise. Occasionally the curl is turned in the opposite direction, but the other arrangement (counter-clock) is far the more frequent. The animals adopt various attitudes when spawning, but in some cases at any rate Dorids arch their lower surface and stand over the ribbon as it issues from them. The spawn of British species seems to be always white, at most tinged with rose or yellow, but some tropical Dorids deposit very beautiful red or violet spirals, which look like flowers.

[1] Observed by Trinchese and by Hecht, who notices that it pulsates from twenty-four to fifty-six times a minute.

[2] Our specimen at Plymouth laid fifteen inches in twenty-four hours.

V.

EMBRYOLOGY AND LARVAL STAGE.

The development of Nudibranchs, especially the Cladohepatica, has been studied by various authors[1] in the earlier stages up to the point where the animal leaves the egg and swims about freely as a veliger covered with a shell. But the changes by which this form becomes metamorphozed into an Æolid or Dorid have hardly ever been observed. In fact since the time of Schultze, who in 1849 saw the animal which he calls *Tergipes lacinulatus* (probably = *Galvina exigua* A. & H.) pass from the veliger stage and assume the first outline of its adult shape, no naturalist seems to have been able to keep veligers alive for more than a short time, at any rate not in conditions sufficiently favourable to permit further development. Neither I myself nor Mr. Nelson nor Mr. Elmhirst, who have kindly endeavoured to rear the larvæ of *Doris tuberculata* on my behalf, have ever been successful in breeding the creeping form in captivity. The veligers often die soon after hatching, and, though they may in some cases live as long as three weeks, they show no sign of assuming the shape of the adult.

According to Smallwood[2] the eggs of Nudibranchs are fertilized in the oviduct just before deposition, the head of the sperm entering the egg, and the tail being left outside. The period between copulation and egg-laying varies greatly in different species. In some it is from twelve to twenty-four hours. In *Doris tuberculata* in captivity it is eight days or more. The following notes refer to that animal. The eggs appear to remain unsegmented for about twenty hours after they are laid, at the end of which time some of them were observed to show the first cleavage.[3] About sixteen hours later began the second cleavage. Nine hours after that sixteen cells were visible in some eggs, and again about eighteen hours later thirty-two cells. On the tenth day it could be seen that the embryos had begun to develop oral lobes, and a few days later that they had assumed the form of veligers and were rotating within the capsule. Sometimes there are two or three embryos in one capsule, in which case one usually develops at the expense of the others. The eggs hatch from fifteen to twenty-one days after they are laid. It is probable that the former is the natural period and that the movement of the tide facilitates the process of hatching. It was materially accelerated in captivity when the ribbon was gently agitated at intervals or placed under a stream of running water. It is also possible that the operculum on the foot of the larva helps it to break through

[1] *Fiona* by Casteel; *Tethys* by Viguier; *Tergipes* (?) by Schultze; several species by Trinchese and Mazzarelli. See Bibliography.

[2] Observations on Chromosome Vesicles in the Maturation of Nudibranchs, Sonderabdruck aus: Morpholog. Jahrb., Bd. xxxiii, H. 1, Leipzig, 1905. The species studied are *Cratena pilata*, *Cr. gouldii*, and *Doris bifida*. The last is unknown to me.

[3] In this and all other questions of time it must be remembered that the unfavourable conditions of captivity may retard processes which take place more quickly in the sea.

the egg-capsule. The larvæ are able to eat almost as soon as hatched. The food consists of unicellular algæ, and the stomach and intestine soon become green and opaque owing to the presence of chlorophyll. The internal organs are clearly visible through the shell, particularly the attachment muscle. The veligers are positively heliotropic, and if kept in a vessel which is partially screened so as to admit the light to only a small portion, which is varied from time to time, they will persistently frequent the light portion. They die, however, if exposed to the sun too freely, and also suffer greatly from the attacks of various Infusoria. For one reason or another all died before casting off their shells.[1]

The most detailed account of the development of a Nudibranch egg into a veliger is that given by Casteel for *Fiona*. The first cleavage forms two cells of equal size, and the same is recorded of *Tethys* and *Ercolania*, but in many Opisthobranchs (*Acera*, *Aplysia*, *Umbrella*, and *Philine*) unequal cleavage is reported. In its earlier stages the egg is radially symmetrical, but with the beginning of gastrulation this radial arrangement gives place to an increasingly distinct bilateral symmetry. A gastrula is formed with a pointed anterior end, and proceeds to develop into a veliger. The blastopore closes, but later the stomodæum opens at the point where it closed. The shell-gland appears first as an invagination and then covers the posterior end of the veliger with a cap of large cells which secrete the shell. The shell is found to be shifted slightly to the left even during the earliest stages, and this asymmetry becomes more marked with the progress of growth; torsion of the enteron also results from its being lengthened on the left side in consequence of increased growth there. The foot arises as a swelling under the stomodæum, and later secretes an operculum on its lower surface. There is no apical sense-organ, but cerebral ganglia are present and also otocysts closely connected with the pedal ganglia; the eyes are late in appearing. Casteel states that the larval kidney moves up to the right and eventually lies above the anal opening; primitive excretory cells are also found in the body-cavity. Keferstein and Ehlers[2] have given a short account of the embryonic development of *Rizzolia peregrina*, which, to judge from their figure, commences with an unequal cleavage of the egg.

It would appear from the various drawings which have been published that there is no material difference of construction between the larvæ of the different classes of Nudibranchs or between any of them and the larvæ of Tectibranchs. Mazzarelli states that those of *Polycera* and *Chromodoris* have eyes, whereas those of *Elysia*, *Hermæa*, *Spurilla*, *Antiopella*, *Flabellina*, *Fiona*, and *Doto* are blind. There would thus seem to be a distinction in this respect between the Holo- and Cladohepatica. All have as their organ of motion a broad, bilobed, ciliated velum, and all have a nautiloid shell, which lies ventrally, the small foot and the lobes of the velum projecting out of it. It is generally smooth, but in some, at any rate, of the Ascoglossa is simply sculptured.

One or more dorsal retractor muscles attaching the animal to the shell are usually

[1] The general failure to rear Nudibranchs from the egg in aquariums must be due to far-reaching causes. Probably the egg-ribbons laid by captive Dorids are not in perfect condition, and the poor health of the embryos further deteriorates in consequence of the absence of tides and the abnormal lateness of hatching.

[2] Zoologische Beiträge, Leipzig, 1861.

conspicuous, and several internal organs are visible, though they have been variously interpreted by different observers. It is clear, however, that the mouth opens between the foot and the head-lobes and leads to the stomach, from which issues an intestine terminating in an anal papilla on the right near the lip of the shell. The liver consists of two portions, differing in size (the left being the larger) and sometimes in colour. There are no special respiratory organs, and most authors agree that there is no trace of a pericardium or heart in the veliger stage, but opinions vary as to the kidneys. At any rate the kidneys are not as in the larvæ of the Streptoneura, where they are thought to be represented by caducous ectodermic projections. In the Opisthobranchiata the organs which have been regarded as renal are closed pouches. This larva, known as a veliger from the two conspicuous ciliated lobes of the velum, is a free-swimming organism, and does not begin to creep until its structure has been materially modified.

It is generally admitted that the whole class Euthyneura is characterized not merely by the absence of the torsion found in the Streptoneura, but by detorsion, that is to say, that an originally asymmetrical process of development is arrested and turned into a secondarily acquired symmetry. In some archaic forms such as *Actæon* and *Chilina* the asymmetry of the adult is still marked, but the Nudibranchs represent the opposite extreme, and such a form as *Doris* shows not only almost complete symmetry in the nervous system,[1] but also almost complete internal and external symmetry in the arrangement of the various organs, only the genitalia (for which it would be hard to find a symmetrical position) remaining on one side. The later development of the larvæ is influenced by the fact that Nudibranchs, unlike their relatives the Tectibranchs, do not grow over the shell until it becomes internal, but break or cast it off at an early stage. Two methods of development may be seen in those Opisthobranchs which, when adult, are really or apparently devoid of shells. In the first the position of the organs is conditioned by the presence of the shell which in the earliest stages of adult growth may be of relatively large size and hollow, although it subsequently may become reduced to a flat plate or membrane. Hence, though detorsion carries the ctenidium and anus some way down the right side, they cannot become postero-dorsal, for they would then lie under the vault of the shell, which is not a suitable position for them. Accordingly, these organs, as well as the renal opening and the osphradium, all lie asymmetrically on the right, and the position of the heart and kidney is also more or less asymmetrical. The mantle shows a tendency to grow over the shell as the animal becomes larger, and may completely enclose it (*e. g. Oscanius*), but the distribution of the organs mentioned is not altered. More rarely (*e. g.* in *Pleurobranchæa*) the shell is entirely absent in the adult and apparently rejected during the larval stage, but growth proceeds as if it were present, and a large asymmetrical ctenidium is developed on the right side. This probably tends to keep the other organs in their places,[2] for they are distributed exactly as in *Oscanius*. But in Nudibranchs the shell is shaken off before any respiratory organs are developed, and there is no limit to the animal's changes of shape except its own plasticity. In these circumstances it seems natural that symmetry should assert itself, though it might be difficult to give any logical reason for holding symmetry to be natural. But

[1] The symmetry is not so absolute as is generally supposed.

[2] The anus is near the gills in most varieties of the molluscan organization. The gills, which create a current of water, cause the excreta to be carried off and are not fouled themselves.

in any case there can be no doubt of the strong tendency in this group of Mollusca to produce internal and external symmetry.

In the Nudibranchs there is never a ctenidium nor any organ corresponding to it morphologically. Functionally, various new forms of gill take its place, and they are always symmetrically arranged, either in the median line of the posterior dorsal surface, or along the sides, or under the mantle. At the same time there is a tendency to make the alimentary tract follow the longitudinal axis of the body, so that the mouth being anterior the anus will be posterior. But this arrangement is never perfectly attained. In most Cladohepatica the anus is lateral, in some Ascoglossa it is even anterior, and even when it is postero-dorsal or terminal, as in the Holohepatica, the internal flexure of the intestine testifies to an older arrangement. But the heart, liver, and kidney assume symmetrical positions, and though the genitalia cannot do this as a whole, the hermaphrodite gland in many forms spreads itself over the liver as a roughly symmetrical layer or appears as one or more symmetrical masses. In both cases it ceases to be a dextral organ. The conversion of the hermaphrodite gland into a layer illustrates another feature of Nudibranch anatomy, which is possibly connected with the freedom of expansion offered by the soft molluscan body when not confined by a shell, namely, the tendency to convert into ramified systems organs which in other groups are compact masses or simple pouches. This happens to both the liver and the kidney, and in the Ascoglossa to some of the accessory genitalia. The ramifications, though incredibly complicated, are roughly symmetrical, that is to say they extend themselves evenly as far as they find room.

The phases in which these tendencies find expression and convert the practically uniform veligers into Nudibranchs of very diverse structure are still imperfectly known, and the brief paper of Schultze (1849) "Ueber die Entwickelung des *Tergipes lacinulatus*" supplemented by Fischer[1] appears not to be superseded. Nordmann's "Monographie des *Tergipes edwardsii*" (1845) also contains some account of the animal's post-larval development. The first change according to Schultze is the gradual obliteration of the bilobed velum which begins on the second day and is completed in from nine to ten hours. Then the shell and operculum are thrown off, there being some irregularity in the different individuals as to whether these or the velum are the first to be completely lost. At this time (about two days after leaving the egg) the jaws begin to form, but there is no trace of the later ramification of the liver. The next important change is that the visceral mass, which has previously formed a rounded hump separate from the foot, settles down and forms an upper layer symmetrically disposed above the foot. The animal has now become a creeping, not a swimming organism, and has the form of a minute slug without tentacles or dorsal appendages. Jaws, radula, and eyes are well

[1] Fischer in his 'Recherches sur la Morphologie du Foie des Gastéropodes,' Lille, 1892, treats of the development of the same animal (under the name of *Æolis exigua*) with special reference to the liver. This organ consists of a right and left portion, of which the latter becomes much larger and supplies the posterior as well as the left portion of the gastrohepatic system as it appears in the adult. He states that the growth and division of the liver in Æolids show that it is strictly homologous to the liver of other molluscs, in spite of its different appearance. The contents of the cerata are not to be regarded as glandular prolongations of the intestine but as lobules of the original double liver which have become separated. His account of the order in which the cerata appear is not quite the same as Schultze's.

developed. The stomach shows two or three cæca and the anus is median and posterior. The animal begins to eat hydroids. On the fourth day appear the two rhinophores in front and two cerata behind, containing diverticula of the alimentary canal. The anal papilla lies between them.[1] Twenty-four hours later appears a second pair of cerata, in front of the first. At this stage no cnidosacs are present, but the alimentary diverticula are formed at the same time as the cerata. The cerata continue to grow, usually appearing by pairs, at first only in front of the first pair, but subsequently also behind. When four to five pairs have appeared, accessory lateral cerata begin to be protruded until the front groups consist of two or three cerata each. The heart is very late in making its appearance, and is never formed until three or four pairs of cerata with their liver diverticula have been developed. Schultze states that it sometimes does not appear until four weeks after hatching. Nordmann, on the contrary, states that the heart may be seen clearly beating in *Tergipes edwardsii* before the velum is lost, and that the oral tentacles are visible at the same time; also that the first cerata to appear are the most anterior pair, all subsequent pairs being posterior. But there is no reason to suppose that the development of all Æolids need be uniform in its details.

The remarkable *Pseudovermis* described by Kowalevsky might be supposed to be an early stage of an Æolid before the cerata or hepatic diverticula are developed, especially as no heart was discovered with certainty. But, apart from the facts that it is said to lay eggs, the presence of cnidosacs is against this hypothesis.

Of the phases through which Dorids pass after the veliger stage practically nothing is known, efforts to rear *D. tuberculata* from the egg having, as already mentioned, not proved successful. Garstang[2] states that the young *Ægires punctilucens* is pure white with a series of very spiny tubercles, and only later acquires brown pigment. He collected a complete series of these young forms, which enabled him "to identify as a still earlier stage of the same species a remarkable post-larval form which had occurred in the autumn tow-nettings as observed by Mr. Bles at Plymouth and Mr. Vallentin at Falmouth. It was simply one of these minute white *Ægires* with the addition of a pair of large velar lobes with which it swam freely in the water." It would appear from this that the animal had assumed the form of a Dorid when free-swimming and still retaining its velum. But it may be observed that *Ægires punctilucens* is not remarkably doridiform even when adult. The smallest Dorids which I have seen are about a millimetre in length, and colourless. The tubercles and the spicules are both relatively much larger than in the adult *D. tuberculata*, though in making this comparison it must be admitted there is no absolute proof that the young forms belong to this species. As far as can be seen in such minute objects the branchiæ and their pocket are distinctly developed. At a later stage when the animal measures 4–5 mm. in length the dorsal tubercles are still large, and spots of brown pigment appear between them.

The exceptional development of *Cenia cocksi* has been described by Pelseneer.[3] It is the only Nudibranch which is known to spend its larval stage within the egg and to quit

[1] In the adult *Galvina exigua* the anal papilla is latero-dorsal between the second and third rows of cerata.

[2] "Faunistic Notes at Plymouth during 1893–4," Journ. Mar. Biol. Assoc., vol. vii.

[3] "La condensation chez un nudibranche," Trav. Stat. Zool. Wimereux, vii, 1899.

the egg in the adult form. Compared with most other Nudibranchs this species lays very few eggs (six to twelve) at a time, which in captivity hatch after eighteen days. The velum does not attain to more than a rudimentary stage of growth and is then obliterated before hatching, but at no stage in the process is there any sign of a shell-gland or a shell. The foot lengthens, uniting itself with the visceral mass, and the hepatic diverticula begin to form. It is only when these changes are complete that the animal leaves the egg, having attained the adult form except that the tentacles and genitalia are not yet developed.

VI.

ANATOMY.

The anatomical descriptions scattered through the works of Alder and Hancock are believed to be due almost entirely to the latter author, who also wrote on these questions both in conjunction with Embleton and in his own name only. They are of such excellence that they still furnish for many purposes the best and clearest account of the internal organs of the Nudibranchiata. But naturally the prolonged and detailed researches of Bergh, Trinchese, Vayssière, and other investigators, have collected many new facts respecting the structure and functions of these organs, and also, it must be confessed, that lucid as are the anatomical sections of the Monograph, the authors frequently employ a terminology which is not only antiquated but erroneous. This is not a mere matter of words; when for instance Alder and Hancock call the hermaphrodite gland the ovary, a wrong (or at least an incomplete) view of its functions and even of its structure is implied. But a detailed criticism of their accounts would not be very readable or profitable, and it will perhaps prove more useful to write fresh anatomical descriptions of *Doris tuberculata* and *Æolidia papillosa*. The repetition which this entails is, I hope, justifiable, for it is so difficult to find language which gives a clear idea of the structure of invertebrates, that a re-statement of known facts in new words is often of assistance.

I have selected the two animals mentioned because they are of considerable size and are common on our coasts; they also represent in their most usual and highly developed form the types of structure characteristic of the Holo- and Cladohepatica respectively. In speaking of them as types it is not, of course, implied that all the members of the two classes are constructed on the same plan as *Doris* and *Æolidia*. On the contrary there is considerable variety of structure, as will be made plain in the chapter on classification. But of the Nudibranchs hitherto described probably two thirds are either Dorids or Æolids, and these two classes certainly exhibit the two schemes of construction which have proved most successful for shell-less marine molluscs. In details, however, it cannot be assumed that all Dorids are like *D. tuberculata*, and still less that all Æolids are like *Æ. papillosa*. Comparatively few forms, especially in the tropical genera, have been thoroughly examined, but we know that general uniformity of structure throughout a class is not incompatible with occasional unexpected variation in particular points.

1. DORIS TUBERCULATA.

Doris tuberculata is roughly oval and is shaped much like a half-lemon. On the back, which is covered with flat tubercles of various sizes, are two openings for the rhinophores in the front part: in the median line but near the end of the body is a larger single opening

for the branchiæ. Within the branchial circuit are also the anal and renal papillæ. The dorsal surface is produced so as to form a free flap, or mantle-margin, all round the body. The ventral surface is formed by a broad creeping sole commonly called the foot. Its margin is somewhat expanded, and in the furrow formed between it and the mantle-margin there lie in front the mouth and on the right side near the anterior end the orifices of the genitalia. On either side of the mouth is an oral tentacle, which in this species takes the form of a thick knob marked with a groove. In other Dorids these tentacles are thin and conical. When the genitalia are contracted the orifices appear as a simple pit, but when they are extended it is seen that three orifices open into this pit. The male orifice is the most anterior; behind it is the channel through which fertilization takes place; below this and slightly behind it is the orifice of the oviduct.

The dorsal integuments are fairly thick and contain numerous short spicules slightly bent in the middle. These spicules are relatively much larger in the young animals and are to some extent absorbed in the adult, leaving cavities to mark their places. At the sides the body-walls are thick but spongy, being full of blood-lacunæ. The foot consists of a spongy and of a muscular layer.

The internal organs of *Doris* fall into five principal divisions:

(1) The alimentary system, consisting of the buccal mass, œsophagus, stomach, liver, and intestine. These organs are arranged in rough but not complete symmetry along the main longitudinal axis of the body, from the mouth in front to the termination of the intestine among the branchial plumes near the end of the body.

(2) The nervous system and sense-organs. The former consists chiefly, but not entirely, of a collar of ganglia set round the œsophagus; the latter of rhinophores, eyes, and otocysts, a pair of each.

(3) The respiratory and circulatory systems consist of the branchiæ, the heart, the blood-vessels, blood-spaces, and the blood-gland.

(4) The renal system is a ramified organ lying on the top of the liver and communicating with the pericardium.

(5) The reproductive system is extremely complicated and comprises three parts: (*a*) The hermaphrodite part consisting of a gland spread over the liver in the form of a thin layer, which finally discharges its products into a tube which bifurcates; (*b*) the anterior branch of this tube is the male portion, which is not further divided; (*c*) the other branch is the female portion, which is again divided into the vaginal section, bearing two spermatothecas, and the uterine section, which is connected with two large glands that secrete the various envelopes enclosing the egg.

If the back of *Doris* be taken off like a lid by an incision under the mantle-edge extending round the body, the intestine and membranes below the branchiæ being cut, most of the above-mentioned organs will be seen lying as if packed in a box.[1] Immediately behind the mouth is the buccal bulb containing the masticating apparatus. From it a tube, the œsophagus, which is surrounded by the nerve-collar, runs into and to some extent under the stomach. This organ lies on the anterior end of the liver, which

[1] See Monograph, Plate 1, Fam. 1, fig. 2. The plates in the Monograph marked Fam. 1, pl. 1, and Fam. 1, pl. 2, may be consulted for illustrations of the organs described in this chapter, but it should be noted that many figures are not of *Doris tuberculata*.

forms a compact mass filling the posterior half of the body. Though nearly the whole of this mass is liver, yet its colour and external appearance are due to the layer of the hermaphrodite gland which envelopes it. On its upper surface lie the heart in the pericardium, and the intestine, which, issuing from the anterior portion of the stomach, describes a bend forward and to the right before running backwards to the anal papilla among the branchiæ. On the liver lie also the renal organ and the aorta, but they are not conspicuous owing to their colourless transparency. The right anterior portion of the body-cavity is filled with the genitalia. Their bulk is very variable according to the condition of the animal, but in the breeding season they are much dilated and extend under the œsophagus towards the left.

In a preserved specimen the intestines are generally of a uniform yellowish colour, but if a freshly killed *Doris* be opened much greater diversity will be seen. The membrane enveloping the viscera has usually a pale purple tinge, deeper in some places than in others. The buccal mass and œsophagus are yellowish-grey, while the nerve-collar surrounding the latter is of a deep orange. The stomach varies in colour according to its contents, but is often brownish-green. The pouch attached to it is generally olive. The liver is of a deep sage-green, but can hardly be seen as it is almost entirely covered by the hermaphrodite gland, which is cream-coloured, with very fine red and yellow markings due to the sympathetic nervous system. The ampulla of the hermaphrodite gland is dead opaque white and the penial bag translucent white. The spermatotheca is brown or colourless, according as it is full or empty, and when it is brown the spermatocyst is generally yellow. The mucus-gland is pellucid white, but the albumen-gland and the parts adjoining it are rather bright orange.

Alimentary System.

The mouth leads into the oral tube, a short chamber with longitudinally lamellated walls. Just before the entrance of the main buccal cavity these lamellæ are interrupted by a ring-shaped depression running round the inner wall of the oral tube. The buccal cavity is entered by the inner mouth, which is a slit in the labial disk. This disk is thick at the sides, but channelled at the bottom so that when the roof of the buccal cavity is cut, as is usual in dissection, it falls apart in the form of two pads. In *D. tuberculata* it is merely covered with a strong cuticle, but in some forms (*e. g. Cadlina*, *Rostanga*) it is strengthened by a ring or plates formed of minute chitinous rods.[1] The floor of the buccal cavity is formed by the odontophore, a tongue-like prominence divided into two halves by a longitudinal furrow and formed chiefly of cartilage. It is attached by bands of muscular fibre to the radula, a membrane covered with small hooks or teeth, which can be drawn backwards and forwards over the odontophore as over a pulley, and thus tear to pieces any substance which may be pressed against it. The radula fits into the groove of the odontophore, being depressed and folded in the middle. There are no teeth on

[1] Alder and Hancock commonly speak of this arrangement as a prehensile or spinous collar. But the expression is misleading, for the armature even when circular is not a collar which fits round anything, but a thickening on the inside of a tube.

this median line, but on either side of it are from forty to fifty rows, each containing between fifty and seventy and sometimes as many as ninety teeth. The radula emerges from a curved sac which hangs down behind the buccal mass and contains special cells which continually secrete new teeth. The front of the radula becomes worn by use and thus the anterior rows of teeth are much damaged, but as they drop off fresh rows emerge behind from the radula sac and the whole apparatus moves forward. In a large *Doris* about twenty rows of teeth are in use on the odontophore and twenty-five more remain in reserve behind, while six are still in process of formation. The organs mentioned are often described collectively under the name of the buccal mass, and as seen lying in the body-cavity present the appearance of a roughly conical bullet. The whole mass is capable of considerable movement backwards and forwards, and (in some species at any rate) can be everted. These movements are effected chiefly by three pairs of anterior retractor muscles attached near the line where the oral tube passes into the buccal cavity, and a single pair of posterior retractors attached to the lower surface of the cavity just in front of the radula sac. But probably the animal can control the pressure exercised upon various organs by the blood which fills the body-cavity and everts the buccal parts by concentrating the pressure on them.

At its posterior end the buccal cavity passes into the œsophagus, and just at this point enter the ducts of two salivary glands, one on either side. They are long band-like structures traversed by a central canal which pours its secretion into the buccal cavity near the root of the tongue.

The œsophagus is a fairly broad tube, which may be an inch long, with thin walls bearing internally not very conspicuous longitudinal lamellæ. It runs straight to the stomach and under it, entering it posteriorly on the lower surface, whereas the intestine issues from the stomach anteriorly and on the upper surface. This arrangement, which seems most unnatural in a symmetrically disposed animal, is clearly explicable by the larval structure in which the alimentary canal was U-shaped, the mouth and anus forming the ends of the two limbs, and the stomach the base of the U, but lying rather to the right. When this arrangement was replaced by longitudinal symmetry, in which the mouth remained anterior and the anus became posterior, the front part of the right limb of the U was bent round and prolonged backwards, but the U was not pulled into a straight line, and the direction which the intestine even now takes in starting still indicates its original destination.

The stomach is a large bag lying in an anterior cleft of the liver, rather to the left of the median line. Its walls are thin, more or less lamellated[1] but not at all muscular, and take their colour from the contents, which often render the organ conspicuous among the other viscera, since when distended with fragments of red or dark sponge it appears as a red or black mass. Into the posterior part open four or five liver-ducts[2] and also a pear-

[1] This lamellation varies greatly in different individuals. Sometimes the walls are almost entirely smooth.

[2] From different points of view it is equally correct to say that there are four or five liver-ducts, or that there is only one. The stomach, which is a roughly conical bag, communicates with the liver at its narrow end. If this narrow end is regarded as a tube we may say that the various liver-ducts unite in one duct before entering the stomach. But its tubular character is not very distinct, and we may equally well say that four or five liver-ducts open into the narrow end of the stomach.

shaped gastric pouch, whose orifice in the stomach-wall is closed with a more or less distinctly developed flap. This pouch is often called the gall-bladder, but nothing indicates that its functions correspond to this name. Its walls are glandular, and appear to secrete globules of a glistening material which is also found in the intestine. It is possible that this secretion subsequently dissolves and forms a membrane which is found to cover the walls of the stomach and intestine, and probably serves to protect these delicate surfaces against the spicules abounding in the sponges on which most Dorids feed. The intestine is a long thin tube with longitudinally laminated internal walls. It does not seem probable that in this species it takes any part in the work of digestion or absorption. It runs forward almost to the level of the nerve-collar, makes an abrupt turn to the right across the œsophagus, and runs backwards to the branchial circuit, within which it terminates as a tubular papilla set not quite symmetrically but rather to the left of the centre.

The Nervous System.

The nervous system consists of two parts, one known as the central nervous system which takes the form of a collar round the œsophagus with peripheral nerves springing from it, and another which is less conspicuous and distributed over the viscera. This is commonly called the sympathetic nervous system, but perhaps accessory would be a better name. As seen from above the central nervous system is enclosed in a semi-transparent membranous capsule. When this is removed there are seen more plainly three pairs of ganglia, divided by a median depression into two halves, one ganglion of each pair being right and the other left. The cerebral and pleural ganglia are usually spoken of as a single group (cerebro-pleural) because they are more or less united into one mass. The pedal ganglia, lying at the side, are more definitely independent though partially fused with the others. Seen from below (see Text-figure 1, p. 42), the ganglia are found to be fastened round the œsophagus by three bands, which are not, however, all similar. The most anterior is a simple thread or commissure (*a*) which unites the two cerebral ganglia and near its roots is fused with a nerve coming from them.[1] The second band (*b*) bears ganglia, and is to be described in the greater part of its length not as a commissure uniting the right and left members of a pair of ganglia, but as the cerebro-buccal connectives, running from the cerebral to the buccal ganglia. These latter almost touch one another and are closely applied to the lower surface of the œsophagus, just behind the buccal mass. To the posterior part of them are attached the small gastro-œsophageal ganglia. The third band (*c*) consists of three commissures united in a common sheath but showing a distinct origin at their roots; these are called the subcerebral, pedal, and pleural commissures. Beneath the right pleural ganglion lies a smaller unpaired ganglion (*d*), not visible from above, which may be called visceral. Compared with Tectibranchs such as *Aplysia*, *Doris* shows a double modification in its nervous system. The visceral connectives are shortened, and the parieto-visceral ganglion complex (itself formed by the fusion of nerve-centres) is drawn up into the nerve-collar, and secondly the single ganglion representing this complex is put on one

[1] This anterior commissure, sometimes called labial, appears to be recorded only for *Archidoris*.

side and almost obliterated. But the nerves which it sends to the genitalia and viscera are studded with beads consisting of ganglionic cells.

The chief organs of sense are directly connected with the cerebral ganglia. From their anterior extremity rise the almost sessile olfactory ganglia which send a nerve each into the rhinophores or dorsal tentacles, highly sensitive pillars bearing on their upper part numerous perfoliations and retractile into two pits. The rhinophores are in direct communication with the water, but the eyes (whose functional value must be small) are subcutaneous. They lie further back than the olfactory bulbs near the external margin of the cerebral ganglia, to which they are attached by very short nerves. They consist of a capsule containing a cup-like layer of black pigment set round a spherical crystalline lens. Immediately behind the eyes lie the sessile auditory capsules which contain numerous otoconia. The cerebral ganglia give off four other pairs of nerves which innervate the oral tentacles, the mouth, and the lips. The pleural ganglia send off three pairs of nerves innervating the mantle, and the hindmost of the three communicates with the sympathetic system on the right-hand side. The pedal ganglia, which lie a little below the others, give off five pairs of nerves, three large ones which innervate the foot and two small ones which run to the sides of the body. Four nerves arise from the unpaired visceral ganglion and supply the genitalia, the whole alimentary canal, the heart, and the kidney. They communicate with the sympathetic system and differ in structure from the other nerves, since they are studded with beads of ganglionic cells along their whole length. The ganglia beneath the œsophagus are mainly concerned with the nerve-supply of the buccal mass. Each buccal ganglion sends off two rather large lateral nerves distributed over this mass and a small one to the base of the tongue. The gastro-œsophageal ganglia also send off three pairs of nerves, one to the salivary glands, one to the top of the œsophagus, and a third pair, the largest of the three, running side by side down the under surface of the œsophagus and eventually connecting with the sympathetic system.

An examination of several specimens of *Doris* will show that the symmetry of the central nervous system is not absolute or consistent, and that one half is often larger than the other, especially in the cerebral portion. The excess is most commonly in the right half (as seen from above), but there is no rule and sometimes the left is larger.

The accessory or sympathetic system[1] consists of numerous minute ganglia distributed over the viscera and united by an elaborate plexus of nerve-fibres. It is not concentrated or co-ordinated according to any obvious principle, but falls into several divisions corresponding to the parts of the body with which it is concerned, such as the genital plexus and the gastro-hepatic plexus. It communicates as described above with the nerves given off by the central system. In a freshly killed specimen of *D. tuberculata* the ganglia of this system appear as bright orange dots scattered over the viscera. In other Nudibranchs they are not so conspicuous, but the system probably exists.

Respiratory and Circulatory Systems.

These consist of the branchiæ, heart, blood-vessels, blood-spaces or sinuses, and the blood-gland. The meaning of the first three terms will be plain. In the Nudibranchiata,

[1] See Béla Haller, Beiträge zur Kenntniss der Nerven im Peritoneum von *Doris tuberculata*, Vienna, 1884. But the statements contained in this paper have been criticized.

as in other Mollusca, the whole body-cavity is filled with hæmolymph or blood-fluid, so that the blood-spaces and blood-vessels may be regarded as merely divisions or diverticula

Fig. 1.

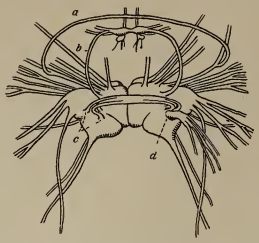


Fig. 3.

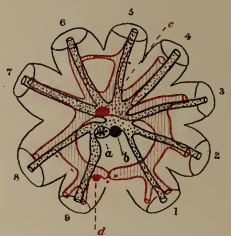


Fig. 1.—Central nervous system of *Doris tuberculata* seen from below: *a*, commissure uniting cerebral ganglia; *b*, cerebro-buccal connective; *c*, common commissure; *d*, unpaired (visceral) ganglion.

Fig. 3.—Diagram to illustrate the circulation of the blood in the branchiæ (the afferent system is marked in black, the efferent in red): 1—9, cut ends of branchial plumes showing the two sets of blood-vessels; *a*, anal papilla; *b*, point where the hepatic sinus communicates with the afferent system; *c*, point where the efferent system communicates with the auricle; *d*, one of the points where the efferent system opens into the lateral blood-sinuses.

Fig. 2.

Fig. 2.—Lower side of internal organs of *Doris tuberculata* showing portions of central and accessory (sympathetic) nervous systems: *a*, cut end of radula-sheath which has been removed to show organs lying below it; *b b*, buccal ganglia; *c c*, gastro-œsophageal ganglia; *d d*, œsophageal nerves springing from *c c* and uniting with the stomachic plexus at *e e*; *f f*, under side of stomach showing the part of the accessory nervous system called stomachic plexus; *g g*, cut ends of salivary glands; *h*, œsophagus; *i*, nerve from the unpaired visceral ganglion innervating *j*, the penis sac; *k*, another nerve from the same ganglion which bifurcates and sends off a branch *l* uniting with the stomachic plexus.

of this general cavity, which is sometimes called the hæmocœle. The blood-spaces are either intervisceral, or form lacunæ in the tissues of the body-wall, which owes its

spongy character to their presence. The blood-gland is a leaf-like body of considerable size, communicating with a branch of the aorta and also with the capsule of the central nervous system, which is bathed with a special supply of blood. It consists of two main

Fig. 4.

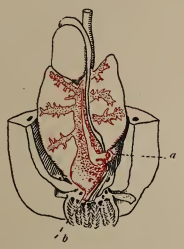


Fig. 5.

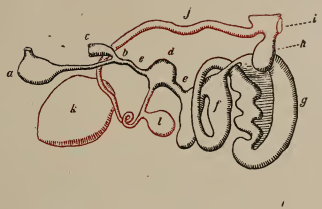


Fig. 4.—Renal organs of *Doris tuberculata*; the heart and pericardium which lie above have been removed, and the renal organ (red) is seen lying on the surface of the hepatic mass; *a*, portion of the cut pericardial wall remaining round the point where the pericardium communicates with the renal organ; *b*, renal pore.

Fig. 5.—Diagram of the female genitalia of *Polycera quadrilineata* in which the different parts are separated from one another (after Pohl); the oviducal and uterine portion is coloured black; the portion which receives and stores the spermatozoa is coloured red: *a*, ampulla of the hermaphrodite gland; *b*, bifurcation where the male and female branches divide: *c*, commencement of vas deferens (rest not shown); *d*, fertilization chamber; *e e*, oviduct; *f*, albumen of gland; *g*, mucus gland; *h*, external duct of the mucus gland; *i*, atrium genitale; *j*, vagina; *k*, spermatotheca; *l*, spermatocyst.

Fig. 6.

Fig. 7.

Fig. 6.—Genitalia of *Doris tuberculata* (red and black used as in Fig. 5): *a*, stomach; *b*, layer of the hermaphrodite gland spread over the liver; *c*, hermaphrodite duct; *d*, ampulla of the same; *e*, point where the male and female branches bifurcate; *f*, vas deferens; *g*, penis sheath; *i*, vaginal duct; *j*, spermatotheca; *k*, spermatocyst; *l*, albumen-gland; *m*, mucus-gland; *n*, external duct of mucus-gland; *o*, cut end of body-wall.

Fig. 7.—Anterior genitalia of *Æolidia papillosa* (the male branch is marked with cross lines ═; the vaginal duct and spermatotheca are in red): *a*, duct of the hermaphrodite gland (the gland itself is not shown); *b*, ampulla of the duct; *c*, coils of the vas deferens; *d*, penis sac; *e*, male orifice; *f*, point where the oviduct begins; *g*, albumen gland; *h*, a portion of the shell-gland; *i*, mucus-gland; *j*, external duct of mucus-gland; *k*, female orifice; *l*, spermatotheca; *m*, cut end of body-wall.

lobes, each divided into about three secondary lobes. In preserved specimens it is very apt to be crushed or pulled out of place, but its natural position seems to be immediately above the central nervous system, the two main divisions lying respectively somewhat

before and behind the ganglia. The functions of this gland have not been ascertained with precision. There are indications that it provides some of the constituents of the blood, as the colourless circulating fluid may be termed for brevity, and that it produces phagocytic cells which destroy pathogenic microbes.

The structure of the gills or branchiæ varies greatly in the different families of Nudibranchs, but in all it seems clear that they only undertake part of the work of respiration which is also performed by the integuments generally. Respiration means the process by which the blood is passed through vessels where it is separated from the water only by a thin membrane, and it is clear that in a thin-skinned shell-less mollusc this can be done on any part of the dorsal or even lateral surface. But since the majority of Nudibranchs (especially large Nudibranchs) have specialized gills, it must be necessary or advantageous to supplement this dermal respiration without suppressing it. In *Doris* the branchiæ, though more highly organized than in any other family, deal only with the blood going to the main visceral mass (liver, kidney, and hermaphrodite gland): the rest of the blood passes into a system of intervisceral blood-spaces, thence into the lacunæ in the integuments, and from them is returned direct to the auricle by two lateral veins.

The pericardium, which contains the heart and communicates with the renal system through a special valvular apparatus, is placed symmetrically on the upper surface of the posterior visceral mass. Its inner wall bears some raised folds which have received the name of pericardial glands. They are not equally developed in all specimens. The heart consists of an anterior roundish chamber, or ventricle, with thick walls, from which issues the aorta, and a broader posterior chamber, the auricle, with thin walls, which communicates with the efferent part of the branchial system, and receives the great lateral blood-sinuses. The branchiæ consist of several (seven to nine) plumes whose structure is somewhat complicated in this and other species owing to their elaborate subdivision, and is seen more clearly in forms like *D. verrucosa* where each plume is only simply pinnate. But the essence of the arrangement is the same in all. The impure blood arriving from the hepatic trunk-vein passes up the inside of the plumes in the afferent blood-vessel and is distributed throughout the membranous pinnæ. It is then collected again in the outer or efferent blood-vessel and returns to the auricle through the round efferent sinus at the base of the branchial circuit. The arrangement of the afferent and efferent systems in the branchiæ is, like so many details in the anatomy of *Doris*, not perfectly symmetrical (see Text-figure 3). The afferent system does not form a circle but resembles a horse-shoe bent somewhat asymmetrically round the anal papilla but remaining open behind,[1] and sending branches to the plumes. It communicates with the lateral blood-sinuses and the hæmocœle. The efferent system describes a complete but still not quite symmetrical circuit round the anal papilla, and its two ends, though uniting posteriorly, do so only at one point and not with their whole diameter. The branchiæ can be retracted into their pocket by the action of numerous retractor muscles inserted partly in the dorsal integuments and partly in the foot. Their protrusion from the pocket seems to be effected by blood-pressure from the inside.

The aorta, issuing from the ventricle, runs both forwards and backwards. The

[1] Its form suggests that it is derived from the arrangement found in many Polyceridæ in which the branchial plumes form a short curved line in front of the anal papilla, *cf. Ctenodoris*.

posterior aorta divides into two and supplies the visceral mass. The anterior aorta runs to the anterior end of the body, giving off branches right and left on its course. It passes under the buccal mass, into which it sends one branch, and is continued in another branch as the pedal artery in the floor of the body-cavity. This, after sending off branches in all directions, finally opens into the great abdominal blood-space. Thence the blood passes into the system of blood-sinuses in the integuments and is returned to the auricle through the main lateral blood-sinus. The blood in the visceral mass, however, passes into various small veins which unite with the main hepatic venous trunk opening into the afferent system of the branchiæ, where the blood is purified as described.

Renal System.[1]

The general principle underlying the very diverse renal organs of the Mollusca is that they are canals opening internally into the pericardium and also externally, which extract and excrete waste products from the blood. In the Nudibranchiata this simple structure apparently disappears as the organ becomes subdivided and ramified, but the essential character of a cavity (though often of a most complicated and elaborate shape) provided with special walls and communicating with the pericardium and the water still remains. The renal organ in *D. tuberculata* (see Text-figure 4) is not so complicated as in some of its allies. It lies on the visceral mass beside the intestine, under the pericardium and over or among the follicles of the hermaphrodite gland. In shape it is somewhat dendritic, consisting of a central trunk and five or six main lateral branches as well as numerous smaller ones. The substance of the kidney consists of fine tubes lined with cells of a special type, which are also found in the delicate membrane forming the dorsal wall of the whole organ. Down its main trunk runs a cavity which communicates with the pericardium through a pear-shaped vesicle (sometimes described as a funnel, Nierenspritze, or syrinx renalis) with a laminated interior. The description of this organ given in the Monograph is somewhat confusing, because Alder and Hancock term it a portal heart, a mistake corrected in subsequent papers. It is really a valve which allows liquid to pass from the pericardium into the kidney but not to flow in the opposite direction. Pericardial excretory fluid is drawn off by the valve and sent through a duct to the walls of the kidney, which are also traversed by a network of veins in communication with the hepatic trunk-vein which lies below. Hecht[2] found by experiment that if a coloured liquid is injected into the blood of Nudibranchs, the colour, at first spread throughout the tissues, is in a period varying from ten to forty minutes in different forms localized in the renal organ, and completely eliminated in about forty-eight hours.

The renal cells are large and cubical. Near their base they show a concretion formed of solid matter consisting of impurities derived from the blood. Near the upper surface are vacuoles containing a liquid which is excreted by the cells into the renal chamber and thence carried out of the body by the renal opening, which is a minute orifice within the branchial circuit close to the anal papilla. According to some authorities other organs

[1] See Hancock, "On the Structure and Homologies of the Renal Organ in the Nud. Mollusca," Trans. Linn. Soc. Lond., xxv, 1865.

[2] Hecht **1**, pp. 648—658.

(such as the liver and the cells of Leydig scattered throughout the conjunctive tissue) co-operate in the work of excretion.

The Reproductive System.

Topographically this system falls into two parts: (1) The hermaphrodite gland, which is spread as a layer over the liver and not recognizable as a separate organ on superficial examination. (2) All the other organs, which, being collected in the right anterior portion of the body, are often spoken of collectively as the anterior genital mass. Though not organically fused they are mechanically pressed together and connected by membranes, so that being themselves largely composed of thin tubes and vesicles flattened against the large glands which secrete the coverings of the ovum, they are extremely hard to disentangle.[1]

The hermaphrodite gland is of a yellowish colour; it lies among and to some extent below the ramifications of the kidney, but also covers the lower surface of the liver as well as the sides of the cleft in which the stomach is placed. Its appearance differs according to its full or empty condition, but when it is distended with ripe products it appears to form a continuous coat spread over the whole liver-surface. It is really composed of numerous lobes, subdivided again and again. The ultimate lobes consist of a central portion containing spermatozoa, round and above which are smaller globular ovarian follicles, opening into the central portion. All the lobes are connected by a system of fine canals which gradually unite so as to form larger and larger tubes, until at the right anterior end of the liver the two principal tubes may be seen to join in the hermaphrodite duct which passes over to the anterior genital mass.

The size and outline of this mass depend chiefly on the mucus and albumen glands, which are greatly distended in the breeding season.[2] It is more convenient to examine them before this dilatation begins. They are then found to form a roughly oval pad or layer (say 25 mm. long with a maximum thickness of 7 mm. in a specimen of moderate size) pressed against the right anterior body-wall and thinner behind, where it is slightly hollowed in order to accommodate its shape to the liver. The hermaphrodite duct forms a bridge between the two organs (see Text-figure 6), and passes straight from the liver to the inside of the anterior end of the genital mass. There it dilates at once

[1] Though Alder and Hancock described the various reproductive organs with accuracy they seem to have misunderstood their functions and relations. They say quite correctly that the whole apparatus consists of three parts: (1) male, (2) female, (3) "androgynous." But they apparently supposed that these three parts were represented respectively by—(1) the vas deferens; (2) the mucus gland with its annexes, and the hermaphrodite gland which they term ovary; (3) the branch bearing the two spermatothecas. But all naturalists who have studied the group are now agreed that the posterior gland is not a mere ovary, but hermaphrodite, inasmuch as it produces both ova and spermatozoa, which are dealt with separately by the organs of the anterior genital mass. After the hermaphrodite tube has bifurcated, the remaining organs are considered as exclusively male or exclusively female. But if self-fertilization (which is certainly not the rule) were proved to occur even occasionally, the branch bearing the spermatothecas might be described as androgynous.

[2] It should be also mentioned that if they are put under water for dissection they are liable to become enormously dilated.

into a thickish tube (say 2 mm. broad) disposed in a few closely fitting coils and known as the ampulla (*d*). It then bifurcates and sends one branch (female) into the albumen gland (*l*). The other branch (*f*) is the elaborately twisted vas deferens, whose convolutions are piled on the top of the ampulla and hide the point where the bifurcation takes place. They then run over the outer wall of the gland, until the tube, which has been growing gradually narrower, enters the pointed end of a conical bag (*g*). This is the intromittent organ. In the state described (which is that usually found in preserved specimens) it bears a small prominence, the glans, at the bottom of the bag, and it may be compared to the finger of a glove pulled outside in. But on occasion it can be evaginated so that the glans forms its external tip and the vas deferens traverses the whole length of the finger.

The male genitalia of the Dorids are seen in their simplest form in *D. tuberculata*, but in allied genera exhibit many complications: (1) The upper part of the vas deferens may bear a gland of considerable size known as the prostate. (2) There may be accessory glands near the termination of the vas deferens. (3) The vas deferens in its lower part, or the glans, or both, may be armed with spines, or the glans may be armed with a single stylet. (4) The glans is often considerably larger and may assume various shapes.

Whereas in many hermaphrodite Mollusca the female part of the genital system consists of a single passage (with annexes) which serves both to receive spermatozoa and to expel eggs, in the Dorididæ it is divided into two passages, each with annexes, one to conduct the spermatozoa from the copulatory orifice to the unfertilized ova, and the other to expel the fertilized ova after investing them with various envelopes which ultimately assume the form of a nidamental ribbon. Starting from the external opening the first passage commences as a broad tube (*i*), which contracts and passes into the spermatotheca (*j*), a thin-walled vesicle of considerable dimensions, globular in shape if distended, but frequently somewhat flattened. Close to the point where the duct from the exterior enters the spermatotheca another duct leaves it[1] and proceeds towards the oviduct, a name which may be applied to the other branch of the female genitalia, extending from the point where the hermaphrodite ampulla bifurcates into male and female portions (*e*) to the external orifice of the mucus gland.[2] The tube which runs from the spermatotheca to the oviduct bears on its course a second vesicle (*k*), here called the spermatocyst,[3] considerably smaller than the spermatotheca and with thicker walls. It is elongate and somewhat bent: it does not communicate with two ducts like the spermatotheca, but is connected with the main tube by a single short duct and hence looks like a pear on its stalk. After receiving this duct the main tube enters the mucus-albumen gland complex

[1] In some Dorids (but not in *D. tuberculata*) this second duct obviously starts from the wall of the first.

[2] The short stretch between the point where the vas deferens branches off and the point where the duct of the spermatocyst enters is not functionally a common channel which bifurcates into two parts (as is the hermaphrodite duct), but it is the path which the ova traverse on their way to be fertilized and ultimately laid. Hence from beginning to end it is an oviduct.

[3] The nomenclature *spermatotheca* and *spermatocyst*, used by Bergh, seems to me convenient, for it distinguishes the two organs without committing us to any theory as to their functions. But other authors call the spermatotheca *bursa copulatrix* or copulatory pouch, and others again call both organs *receptacula seminis* or seminal bladders.

near the distal end and joins the oviduct. The neighbourhood of this junction probably serves as a fertilization chamber. A pouch which is apparently assigned to this purpose exists in allied forms (*e. g. Polycera*), but has not been found in *D. tuberculata*. We thus see how the spermatozoa introduced by the copulatory orifice reach the ova, but what are the functions of the spermatotheca and spermatocyst? The former probably acts as a bursa copulatrix, and when the genitalia are protruded becomes accessible to the intromittent organ, thus affording a first resting-place for the spermatozoa. It is found[1] to contain not only free spermatozoa, but spermatozoa in packets and also detritus. The spermatocyst, on the other hand, contains only free spermatozoa: it has never been found full when the spermatotheca is empty, but has occasionally been found empty when there were some contents in the spermatotheca. More usually both organs are full or both empty. It therefore seems likely that the spermatozoa are received by the spermatotheca in packets, and that when the envelopes break up they escape and migrate to the spermatocyst. Here they await the descent of the ova into the oviduct. It is probable that most Nudibranchs, though hermaphrodite, exercise their sexual functions alternately and are protandrous. In the pairing season both individuals act as males and afterwards begin to produce ripe ova. Hence the spermatozoa have to be stored for a few days or hours until the ova are ready. But this explanation, though plausible, requires to be confirmed by further observation.[2] It has also been suggested that the function of the spermatocyst may be to supplement cross-fertilization (undoubtedly the normal method in *Doris*) by self-fertilization. According to this hypothesis its contents would consist of spermatozoa which have passed to it from the hermaphrodite ampulla through the oviduct and may be returned to the oviduct again.

The oviduct with its accessory organs forms both in its flattened and in its distended condition a mass of tubules and cavities most difficult to unravel or follow. Its complexity, though astonishing, is not unnatural if we consider that it can secrete an egg-ribbon fifteen inches long and three-quarters of an inch wide. It clearly comprises a powerful secreting apparatus and a most devious channel within whose windings the various secretions are poured on the eggs; the difficulty is to say which tubes are, strictly speaking, parts of the oviduct (that is, the channel followed by the egg) and which belong to glands accessory to the oviduct and opening into its sides. The apparatus must fall functionally into five parts, for the eggs undergo five operations within it: they are fertilized and they receive successively (1) a coating of albumen, (2) an egg-shell, (3) a coating of mucus which combines them into a string, and (4) a second coating of mucus which arranges the string in a ribbon. But morphologically these parts are not clearly separable. It can only be said that the portion known as the albumen gland is yellower than the rest and denser, that is to say formed of smaller tubes. It is definitely a gland and opens into the distal end of the oviduct, though this position is generally obscured by the fact that it is partly surrounded by the coils formed by the rest of the apparatus.

[1] These observations have been made on many Dorids, but they have not all been verified for *D. tuberculata* or for any single species.

[2] *E. g.* to show at what periods the male and female products ripen and whether both individuals spawn as the result of a single act of pairing. It is certain that both spawn subsequently to pairing, but equally certain that one individual sometimes pairs again before spawning.

Among those Dorids which have been adequately described, the structure of the oviducal branch is simplest in *Polycera quadrilineata*,[1] a common British species. In this animal there is a distinct spherical swelling in the oviduct, which doubtless acts as a fertilization chamber (see Text-figure 5). From it the oviduct issues as a cylindrical tube and receives the ducts of the albumen gland, along (or through) a portion of which it passes (*f*). It then emerges again as a cylindrical tube, and it is probable that here the walls of the tube secrete the egg-shell. The portions of the oviduct mentioned up to now can be clearly distinguished from the mucus or nidamental portion which follows. It has roughly the shape of a letter U (*g*). The eggs pass down and up the left and right limbs of the letter, but the space between the limbs is not blank but filled by two membranes enclosing a flattened cavity which communicates all round with the oviduct,[2] or, in other words, its edge is inflated into the tube forming the oviduct. In the left limb of the U the tube is convolute. In the right it is broader and straight. From this broad part a short tube runs to the external orifice of the oviduct (*h*).

The structure found in *D. tuberculata* is essentially the same as that described above, but the different organs are combined in one complex where they can with difficulty be distinguished,[3] and the coils of the oviduct are greatly increased. No investigator has discovered a distinct fertilization chamber, but a flat cavity corresponding to that described above is found in the interior of the mucus gland. The terminal portion of the oviduct (between the mucus gland and the exterior) is strong and laminated internally. It is to some extent extruded during egg-laying when it probably acts as an ovipositor and helps to form the shape of the egg-ribbon.

The complicated organ described above is here called mucus gland in conformity with the usage of several authors. It is also sometimes termed nidamental gland inasmuch as its principal function is to produce the nidamental ribbon in which the eggs are embedded. But though these designations correctly describe some of its principal functions, it may be questioned if it would not on the whole be better to give it the name of uterus, since it is a cavity, continuous, though of very complicated shape, within which the ova are fertilized and prepared for expulsion in the form of eggs with suitable coverings.

The organ here called ampulla of the hermaphrodite gland is often found full of spermatozoa, and there is reason to believe that it acts as a male receptaculum seminis which retains the spermatozoa and does not allow them to pass into the vas deferens until they are wanted. It may on occasion perform the same office for the unfertilized ova, but there appears to be no record of its being found filled with them, and if the account given above of the successive male and female phases is correct there is no reason to collect and hold back the ova. If they descend as they ripen and provoke the secretions of the glands as they pass, they will take their places naturally in the nidamental ribbon.

[1] See H. Pohl, Über den feinern Bau des Genitalsystems von *Polycera quadrilineata*, Halle-a-S., 1905.

[2] It also communicates directly with the albumen gland through a small tube.

[3] A simpler form of the complex is described and figured for *Discodoris vonjheringi* by MacFarland, Opisthobranchiata of Brazil, 1909, pp. 79—82.

2. ÆOLIDIA PAPILLOSA.[1]

Æolidia papillosa differs considerably from *Doris* in appearance. It is roughly triangular in shape; broadest across the rhinophores and tapering towards the tail. The rhinophores are smooth columns, not retractile, and devoid both of perfoliations and sheaths. There are no branchial plumes, but the sides of the dorsal surface bear cerata which entirely cover its posterior part, leaving exposed in front a triangular space behind the rhinophores in which rises a more or less prominent swelling containing the pericardium. The cerata are flattened papillæ, each containing a branch of the liver in the form of a brownish cylindrical core, visible through the transparent integuments. They can easily be detached, and the back then shows a series of circular or oval facets, arranged in about twenty to twenty-five rows. In the middle of each facet is a small orifice corresponding to the end of the liver branch, and with a microscope two minute openings for blood-passages can also be seen. The cerata in front and near the tail are smaller than those in the middle, and also in each row they decrease in size going outwards. In a large specimen the middle rows contain about fifteen. The anterior and posterior rows are shorter. The anal papilla lies somewhat to the right of the median dorsal line between two rows of cerata, usually the tenth and eleventh. The mantle does not form a flap as in *Doris*, but inconspicuous ridges running down each side of the body and meeting at the tail end. In *Æ. papillosa* the dorsal surface overhangs the sides of the body more than in most species, but there is no trace of a fold over the head. The external mouth parts and orifices of the genitalia are much as in *Doris*, but there are only two of the latter, not three.

The topography of the anterior body-cavity[2] (buccal parts, genital mass, and nerve-collar) is much as in *Doris*, but the pericardium lies further forward and the arrangement of the posterior organs is materially altered by the structure of the liver, which consists, not of a compact mass, but of a number of lobes or branches lying wholly in the cerata. As a consequence of this the hermaphrodite gland is not a mere layer on the liver but an independent organ of considerable bulk. The back cannot be taken off like the lid of a box as in *Doris*, but is connected with the alimentary organs in the body-cavity by a number of tubes which have to be cut before it can be removed. Both the integuments and the walls of the various organs are more pellucid than in *Doris*; spicules are entirely absent, and the general texture is spongy. In life the epithelium is provided with vibratile cilia. The skin consists of an outer layer which secretes mucus and an inner muscular layer, varying greatly in thickness in different parts.

[1] Those who are interested in Hancock's anatomical work are recommended to read the series of papers entitled On the Anatomy of Eolis, by Hancock and Embleton, which appeared in the Ann. and Mag. Nat. Hist. for 1845, vol. xv, pp. 1—10 and 77—88; 1848, vol. i, pp. 88—105; and 1849, vol. iii, pp. 183—202.

[2] See for figures illustrating this and other points the plates in the Monograph numbered Fam. 3 plates 7 and 8, and also the articles referred to in the last note.

Alimentary System.

The anterior part of the alimentary canal differs from the same region in *Doris* chiefly in the presence of a pair of mandibles or jaws. These names, though in common use for the organs, are somewhat misleading, for the so-called jaws do not masticate but act as shears which cut off pieces of food to be dealt with by the rest of the alimentary apparatus. They consist of two roughly elliptical laminæ which form the sides of the buccal mass. The anterior and superior margins are considerably thickened and the latter are united by a ligament which acts as a hinge. Viewed from the front, the only portion of the jaws visible is the cutting edge, which is constituted almost entirely by an accessory process distinct from the main lamina. The margins of the jaws both above and below are covered with thick muscular pads, but their sides are merely coated with epithelium both within and without so that the buccal bulb is harder and more angular than in *Doris*. It does not lie evenly in the direction of its long axis, and the opening of the œsophagus is not opposite the mouth. The tongue consists of a high raised prominence, resembling a wedge projecting from the hinder part of the buccal chamber. It bears only a single row of broad crescent-shaped teeth on each of which are forty to fifty denticles. The teeth are continued round the tip of the wedge and extend for a little way on the lower side. The radula sheath is short and does not project behind as in *Doris*. The sides of the buccal chamber are bare for about a third of their extent and are formed merely by the concave side of the mandibles. The rest of the inner surface is lined by a thick muscular pad, which lies against but does not adhere to the mandible.

The mouth parts are provided with an elaborate system of muscles which regulate separately the movements of the whole buccal mass, those of the jaws and those of the tongue. The whole mass can be drawn backwards or forwards by the action of muscular fibres inserted into the circular belt at the base of the outer lips. At the other end the retractors are inserted into the foot, the sides of the body, and the dorsal surface, but the protractors into the upper and posterior margin of the jaws. On the upper surface of the jaws are two transverse muscles, a small one before the hinge and a larger one behind it; on the under surface there is an anterior transverse muscle attached to both jaws, and the inner lip, which is very muscular, acts as a sphincter and brings the cutting edges together. The posterior part of the buccal mass is formed by two layers of muscles uniting the œsophagus to the muscles of the jaws and of the tongue. The wedge-shaped tongue is itself a mass of muscular fibres among which can be distinguished two sets, crossing one another obliquely. Both sets are inserted into the end of the teeth, but whereas one set radiates from the base of the tongue (that is from directly below the middle of the radula) the others run forward from the posterior end of the radula. By acting together or on one side only these muscles can raise or depress the radula, alter its curvature, and move it from side to side. Under the tongue are two semicircular bands of muscle. The lower and larger is attached to the inferior surface of the jaws at one end and to the hind part of the tongue at the other, so that it can pull the tongue downwards and backwards. The other, which is smaller and lies within the curve of the lower muscle, acts in the opposite way and is attached to the front part of the tongue, which it can pull downwards and thus advance the middle part of the organ.

The œsophagus is short, but usually found bent in preserved specimens, that is to say it can be straightened so as to allow of the protrusion of the whole buccal mass. In this species the salivary glands are small, and their ducts which are inserted behind the buccal bulb are long, thin, and inconspicuous. They lead to minute racemose glands attached to the inner side of the dorsal integuments. In most Æolids these organs are long bands, and besides the pair of salivary or post-bulbar glands there are usually ptyaline or prebulbar glands set on the wall of the oral tube in front of the buccal bulb.[1] The stomach is median in position and somewhat elongate. Both it and the œsophagus are lamellated internally. The intestine issues from its right side, and describes a very short curve before running backwards and terminating in the anal papilla. It is broad and has relatively thick walls which are lamellated on the inner side and contain fine muscular fibres, crossing one another in all directions. At the point where it leaves the stomach there begins a ridge which at first runs along its inner dorsal wall (appearing externally as a series of puckers) but tends downwards until it reaches the sides or floor of the tube. In the region of the stomach the ridge is merely furrowed and the intestine finely lamellated, but in their further course both the ridge and the walls of the intestine develop numerous and conspicuous folds which almost fill the lumen of the tube, and apparently act as a sphincter.

Into the stomach open three principal liver-ducts, one on either side and one posterior which is the largest of the three and runs backward along the median line of the body-cavity above the hermaphrodite gland. It might also be described as a posterior prolongation of the stomach. The liver itself lies outside the main body-cavity and is contained within the cerata in the form of lobes, which are flattened and roughly conical in shape, but bear on the surface small folliculate projections. Within each lobe is a central cavity with side pouches corresponding to the projections. This cavity is continued into a tube which passes through the body-wall and unites with other tubes until they all enter the stomach by one or other of the three main ducts already mentioned. It has been proved by experiment that food passes from the stomach into the liver-lobes within the cerata, the passage being facilitated by the alternate contraction and expansion of the stomach and main ducts visible in living animals.

In some œolidiform animals the liver is found partly free within the body-cavity and partly enclosed in the cerata, and even when there is no free portion, the tubes which are ramified within the dorsal integuments or which traverse the body-cavity may be lined with coloured hepatic cells (*e. g.* in *Coryphella rufibranchialis* and *Tergipes despectus*). But in *Æolidia papillosa* the hepatic cells, though varying slightly in distribution in different specimens, never extend far below the bases of the cerata. Below each transverse row of cerata runs a tube into which their bases open, and two or more of such tubes unite to form a broader but shorter tube which enters one of the three main ducts mentioned above. On looking at the arrangement in another way, we may say that the main posterior duct gives rise to six to seven secondary ducts on either side, not set quite

[1] Alder and Hancock do not seem to have found in *Æ. papillosa* the glands mentioned above, and they give the name of salivary to two small glands in the cheeks of the buccal mass. It must be remembered that these designations, salivary, ptyaline, etc., are mere names, and that nothing is known as to the action of the various secretions which they pour into the buccal cavity.

evenly in pairs or opposite one another; these bifurcate once or twice and the cerata communicate with the tubes formed by the bifurcations. The two anterior main ducts are essentially similar to the posterior duct but less extensive.[1] The main ducts have slightly lamellated walls, like those of the stomach but thinner, and are sometimes distended by chunks of food awaiting disintegration and digestion.

As already mentioned, the alimentary system of most Æolids also acts by a most unusual adaptation of its functions as a defensive apparatus. The urticating cells or nematocysts of sea-anemones and other Cœlenterates which the animal eats pass into its stomach and thence to the cerata, where they are excreted by a special process and stored in chambers ready for use. These chambers or cnidosacs are situated at the top of the cerata and can generally be seen clearly through the integuments with (or even without) the aid of a lens.[2] They communicate by very narrow canals with the hepatic lobes which terminate about a millimetre below the tip of the cerata so as to leave room for the cnidosacs. The canal of communication is bent upon itself and is lined with very long cilia, which appear to have the power of stopping the entrance of all bodies except the nematocysts. The cnidosac is lined with special cells (the *cellules nématophages* of Cnénot) shaped like truncated pyramids.[3] These cells appear to attract and ingest nematocysts, which on passing into them almost always assume a position in which the closed end points to the base of a cell and the invaginated end towards its free extremity. After a cell has ingested several nematocysts it undergoes degeneration and becomes merely a membranous bag containing a store of arms. The nematocysts are of various shapes, and as they are derived from the Cœlenterates on which the Æolid feeds, a particular shape is not necessarily characteristic of a particular species of Æolid. But the essential structure of all is the same. They are minute capsules filled with a transparent liquid. One end is closed and the other end is invaginated, the invagination taking the form of a tube. The details of the process of explosion are not quite clear[4] but the result is certain. When a nematocyst has been discharged the capsule remains, but at the end where there was formerly only an invagination there is now a barbed external process which is usually terminated by a long filament and is capable of penetrating and wounding delicate tissues. It does not appear that an Æolid has any power of causing its cnidosacs to discharge nematocysts spontaneously, but when the cerata are bitten or otherwise squeezed (which is of course a violent convulsion for a delicate organ like the cnidosac), the cells are ruptured and the nematocysts discharge as they escape.

Nervous System.

The central nervous system of Æolids is in its essential features similar to that of

[1] The whole arrangement is well illustrated in the Monograph, Fam. 3, Pl. 7, figs. 1—4.

[2] Though *Æ. papillosa* offers many advantages to the dissector on account of its great size, its integuments are less pellucid than those of other species.

[3] There are also between them smaller interstitial cells which do not ingest nematocysts.

[4] See Cuénot and Grosvenor. It is suggested that the eversion of the barbs and thread is due to osmosis and the sudden entrance of water into the capsule. It is supposed that the contents of the capsule are hygroscopic, and, though unable to absorb the concentrated solution which surrounds them in the tissues of Cœlenterates or Æolids, offer a passage to sea-water.

Dorids, and consists of three pairs of large ganglia set on the upper side of the œsophagus and united by connectives (long or short) to various smaller ganglia. The cerebro-pleural ganglia are always fused into a single mass, but whereas this mass appears in many species as an undivided egg-shaped body, in *Æ. papillosa* the cerebral and pleural portions are separated by a distinct furrow so that the œsophagus when seen from above appears to bear six white lumps. The pedal ganglia are round and set more at the side of the œsophagus than the others, to which they are united by two very short connectives on either side, one going to the cerebral and the other to the pleural portion. These ganglia are fastened round the œsophagus by three bands. The first unites the cerebral ganglia to the buccal and to the gastro-œsophageal ganglia which are set as in *Doris* on the lower side of the œsophagus. The second (called the pleural or visceral commissure) unites the right and left pleural ganglia. It bears no ganglia, but from its right hand portion it gives off an unpaired nerve which runs to the genitalia. This arrangement points to the disappearance or diffusion of an unpaired visceral ganglion such as is found in *Doris*.[1] The third band is shorter and thicker than the others. It connects the two pedal ganglia and generally contains within a common sheath the pedal and sub-cerebral commissures. But in *Æ. papillosa* I have not been able to find these two commissures distinctly marked. As in *Doris* the cerebral ganglia are connected with the eyes, otocysts, and olfactory ganglia. The last named lie in the dorsal integuments at the base of the rhinophores, into which they send several nerves. They are large and are united to the cerebral ganglia by rather long connectives. The eyes are not quite sessile but are set on very short processes. The otocysts contain numerous otoliths. The cerebral ganglia also innervate the oral tube, lips, and tentacles. The pleural ganglia each send a nerve along the side of the body, and the pleural commissure gives off the visceral nerve. The pedal ganglia give off two nerves on either side which innervate the foot and also the cerata.[2] The buccal ganglia innervate the buccal mass, and the gastro-œsophageal ganglia send nerves to the œsophagus and also backwards to the viscera. The accessory (so-called sympathetic) system of nerves has not been described for any Æolid so definitely as for *Doris*, since being colourless it is most difficult to detect. But in several Æolids fragments of a network of nerves, with minute ganglia situated on the junctions, have been found, and it is probable that the œsophagus, stomach, liver, and genitalia are all covered with this reticulate system which forms a series of plexuses around the principal organs.

Respiratory and Circulatory System.

The arrangement of this system is not entirely the same in the Æolids and Dorids. The latter have general dermal respiration and also branchiæ localized in a special region. But though the cerata of Æolids may be regarded as branchiæ, they are distributed over the dorsal surface, so that this surface taken as a whole acts as one large respiratory organ, thickly studded with points of special activity.

[1] At the point where the genital nerve leaves the commissure are found, according to Bergh, in *Facelina* ganglion cells and in *Rizzolia modesta* a small ganglion.

[2] The innervation of the cerata is not the same in all Æolids. The nerves come sometimes from the pedal ganglion only, sometimes from the pleural as well. See Herdman and Clubb, Quart. Journ. Micr. Sci., 1891, pp. 550—555.

About the middle of the back can be seen externally a large oval prominence known as the pericardial bulb. Within it is the thin pericardium containing the heart, which consists as usual of a ventricle and auricle. The former, which lies in front, is conspicuous in preserved specimens as a small (4—5 mm. long), opaque, fleshy organ, oval or pear-shaped, with muscular walls. The lumen is reduced by the presence of anastomosing fleshy columns. It opens into the wider but much more delicate auricle which lies behind and a little below it, the communication between the two chambers being controlled by a valve consisting of two flaps. When seen in outline the auricle appears not as a simple bag but as a ramified organ, since it receives broad venous trunks (with branches) on either side and behind. The aorta is large and divided much as in *Doris*. The posterior branch runs above the hermaphrodite gland into which it sends numerous branches; the anterior branch sends the pedal artery into the foot, while in the upper part it divides into the cephalic and genital arteries which supply blood to the mouth parts and anterior genital mass respectively. The cephalic artery is again subdivided into two branches. The arteries terminate in the various viscera and in the foot from which the blood is returned into the general body-cavity or hæmocele. Thence the blood passes into the integuments and from them into the cerata. These latter have on either side of the column of liver substance which they contain a blood-passage, and the two blood-passages are connected by numerous delicate cross-canals. It appears that the blood circulating in the skin and specially in the cerata supplies the hepatic diverticula and at the same time is purified itself, being divided from the surrounding water by membranes no thicker than the branchiæ of *Doris*.[1] The blood passes from the cerata and integuments into various small veins which ultimately unite to form three main trunks. These enter the auricle one on each side and one behind. The posterior trunk receives two small branches from below.

The Excretory System.

The kidney of *Æolidia* is an elaborately ramified tubular organ. It has been described and figured in greatest detail by Hecht,[2] who was able to follow its ramifications by injecting living animals with coloured fluids which are absorbed by the kidney, causing it to appear as a coloured pattern. I have not been able to follow in preserved specimens all the ramifications figured by Hecht, but dissection shows that under the pericardium is a renal organ consisting of numerous minute colourless tubules lined with cells containing concretions. The general structure of this organ, though not its superficial appearance, is as in *Doris*. It lies between the pericardium and the ramifications of the alimentary canal, and, since the latter do not afford a solid support like the liver of *Doris*, its free portions tend towards the dorsal integuments rather than downwards. The whole organ has roughly the shape of the letter Y surrounded by a mass of branching tubules, the limbs of the Y forming the chambers where the excreted products collect in order to be expelled through the renal pore. The renal apparatus connects, as

[1] In *Fiona* the cerata bear a distinct branchial membrane along their whole length.

[2] Hecht 1, pp. 636—642, and Pl. iv, figs 42—45.

in *Doris*, with the pericardium by means of a piriform organ with a strongly lamellated interior.

Reproductive System.

(See fig. 7, p. 43).

The genitalia fall into two portions, the hermaphrodite gland and the anterior genital mass, the hermaphrodite duct forming a bridge between them. The hermaphrodite gland in *Æ. papillosa*[1] is an elongate, conical, and practically solid mass, although it is composed of numerous lobes in contact but still separate from one another. It lies below the main posterior duct of the stomach and fills the remainder of the posterior body-cavity. The lower surface shows a division into right and left halves, which, however, is not very distinct and usually not visible at all from above. The general structure of the gland is as in *Doris*. The smaller follicles contain ova and open into a central space in which the spermatozoa are developed. The animals are protandrous. According to Pelseneer young individuals show merely circular sacs containing spermatozoa with no trace of accessory ovarial follicles. These are developed later as outgrowths of the wall of the circular sac. As in *Doris*, the ducts of the various lobes meet and unite to form a single duct which passes to the anterior genital mass. This varies in size and appearance at different seasons, but consists mainly of an exceedingly intricate mucus-albumen gland complex. The mass is bifid,[2] and the cleft between the two divisions is filled by the spermatotheca, which is often very large and purple.

On reaching the anterior genital mass the hermaphrodite duct swells into the thicker tube known as the ampulla (*b*), which forms two or three short coils and then bifurcates into the male and female branches. The former consists of the long and much convoluted vas deferens (*c*). This organ does not bear a prostate in any known Æolid except *Chlamylla*, but the upper part is often thick and spongy compared with the thinner and more muscular part near the exit. In *Æ. papillosa* the diameter is uniform and the walls consist of three layers; the two outer are muscular and the innermost secretes a fluid.[3] The coils of this tube are extremely complicated and at many points it seems about to enter the mucus-gland, but it terminates in the bag containing the intromittent organ, which is muscular, conical, and of considerable size. Thus the bag need not be entirely everted as in *Doris tuberculata* but forms a præputium around the glans. In *Æ. papillosa* the male genitalia are quite simple, but in other Æolids spines and accessory glands of many kinds are found.

Though the topography of the female organs is not quite the same as in the Dorids, they consist, as there, of two portions or sections, namely the oviducal section in which the ova are fertilized and provided with various envelopes previous to expulsion; and the vaginal section in which the spermatozoa of another individual are received and stored in a spermatotheca. The two sections join before they reach the exterior, and both open

[1] Other Æolids show some variations from this arrangement, though it is the most common, *e.g.* the gland may lie beside or above the branches of the alimentary system, and some lobes may be exclusively male while others are exclusively female.

[2] This conformation is obvious in the breeding season, but less striking at other times.

[3] Probably a prostatic fluid in which the spermatozoa can move.

into one cavity so that externally only two orifices are visible (male and female), not three as in *Doris*.

Immediately after the bifurcation of the hermaphrodite tube into vas deferens and oviduct, the latter makes a short, sharp turn backwards and then a similar turn forwards, thus describing a course like the letter V. From the base of the V issues a fairly long duct which communicates with the spermatotheca, and the right limb of the V bifurcates again. One branch, which is short, enters at once into the mucus-albumen gland complex; the other, which is longer, runs to the external duct of the same complex and debouches with it in a common atrium. The disposition is somewhat difficult to describe, but will perhaps be understood by a reference to Figure 7. It will be observed that in this figure, as in a dorsal view of a dissected specimen, the vaginal duct seems to cross the oviduct because the spermatotheca lies on one side of the oviduct and the continuation of its duct lies on the other. But though the spermatotheca occupies this position in all the specimens which I have examined, it should perhaps be regarded morphologically as merely communicating with the oviduct, not as forming a prolongation on the other side of it. In any case, however, a small portion of tube must function both as the oviduct and as the vaginal duct at different times. The arrangement figured by Alder and Hancock for *Facelina coronata* does not present this peculiarity, but I have not been able to verify their account of the genitalia in that species.

Thus starting from the exterior, the vaginal duct of *Æ. papillosa* begins as an opening in the wall of the female atrium, situated some little distance within and invisible from outside. It then runs straight to the oviduct, unites with it for a short distance and then emerges as a moderately long duct leading to the spermatotheca. There is only one spermatotheca, not two as in *Doris*, and I have not seen in any specimen the organs described by Alder and Hancock as accessory glands, or at any rate have not found them so fully developed. But as it approaches the spermatotheca the duct dilates, becoming somewhat uncertain in outline, and its bulges may sometimes assume the proportions indicated in the Monograph[1] (Fam. 3, Pl. 8, fig. 2). The spermatotheca usually (if not always) exhibits a longitudinal fold (due to the pressure of the mucus-albumen gland complex on either side) which divides it into two portions. They do not, however, appear to have different functions or to be of any morphological importance. The walls of the spermatotheca contain a muscular layer; those of the ducts are thin, fragile, and not muscular.

The portion of the oviduct which lies between the termination of the hermaphrodite ampulla and the albumen gland is short although it comprises two sharp turns. The structure of the mucus-albumen gland complex is a little clearer than in *Doris*, because the component parts are less compressed. It is a coiled and flattened tube (which is simply the dilated oviduct) provided with glandular walls and also receiving the secretion of the albumen gland. Three separate portions can be distinguished: (*a*) The albumen gland. This appears in preserved specimens as a flat, yellowish mass (*g*), not tubular, and harder than the parts which adjoin it. It lies at the back of the anterior genital mass near the point where the oviduct passes into this latter. In external appearance the

[1] The proportions shown in the Ann. and Mag. Nat. Hist. for 1848 (vol. i. pl. 3, fig. 2) are even more considerable.

albumen gland resembles the hermaphrodite gland, that is to say it is a collection of small lobules compressed together. The ducts of these lobules unite to form larger ducts, and the albumen gland, regarded as a whole, is not a passage with glandular walls but an accessory to the mucus gland, into the cavity of which it opens by a single duct. The cells of the albumen gland are full of a secretion which takes a nuclear stain and hence the nuclei of the cells are obscured in sections. (*b*) A portion composed of cells having granular contents. In the figure this portion appears only at the point marked *h*, but it extends behind the coils of the mucus gland shown in the figure until it almost reaches the albumen gland. It is not like that organ an accessory gland, but is a part of the oviducal passage differing from the rest only in the character of its walls. It probably acts as a shell-gland which secretes a shell round each ovum separately, before the ova are collected in groups and arranged in the string of mucus. I have not been able to follow with any certainty the path of the ova in these devious passages, but it seems reasonable to suppose that they first receive the secretion of the albumen gland; then pass through the shell gland, going from right to left across but behind the whole glandular complex shown in Figure 7; and finally pass through the coils shown on the left side of that figure to the external orifice. It will be seen that this orifice lies near the middle of the glandular complex considered as a whole, not at the end, so that the ova must traverse the same distance more than once before they can reach it. (*c*) The mucus gland proper, or convoluted uterus with glandular walls. This large and complicated organ constitutes the major part of the anterior genital mass and falls into two portions, of which that occupying the left side in the figure is considerably the larger. It consists of a coiled and flattened tube, which in places spreads out into wide but compressed cavities similar to the spaces which may be left between sheets of paper. In this labyrinth the eggs are arranged in a string of mucus and along the whole length of the string is attached a thin ribbon or lamina. The lower surface of this lamina is fixed to a solid object when the eggs are laid so that the string can float without wandering from its position. The walls of the mucus gland are formed of glassy cells with small but distinct nuclei.

Although the reproductive organs of Æolids are described in most text-books as diaulic, it will be seen from the above description that they are triaulic; for I understand the essence of the diaulic arrangement to be that the hermaphrodite duct divides into two parts only, namely, (*a*) a male channel, (*b*) a female channel, serving for both fertilization and oviposition, and bearing the spermatotheca as an accessory diverticulum. This is the arrangement commonly illustrated in text-books by figures of *Helix pomatia* or *H. hortensis*. But in the triaulic arrangement the hermaphrodite duct gives rise to three tubes[1]: (*a*) male; (*b*) a channel for fertilization; (*c*) a channel for

[1] This is a convenient description of the structure as it exists, but its origin may be not that the hermaphrodite gland is split into three, or the female branch into two tubes, but that the spermatotheca sends off an additional duct to the upper oviduct. Some aspidobranch Mollusca (such as *Nerita* and *Neritina*), though dicœcious, have the female genitalia divided into two tubes, as in the triaulic Nudibranchs, for copulation and oviposition. In *Septaria* the female genitalia appear to be triaulic by themselves (a greater complication than is known to exist in any Nudibranch), and to have, besides the copulatory and ovipository orifices, a third orifice of unknown functions.

oviposition. These three channels exist in *Æ. papillosa* (which is not in this respect constructed like *Helix pomatia*), but they differ from the corresponding organs of *Doris* in the following points: (1) The vaginal and oviducal passages unite in a common atrium and are not visible as separate openings from the exterior. (2) There is only one spermatotheca, and though it is folded on itself the division appears to have no structural importance. It is possible, however, that the bulges often noticeable near the base may perform the same functions as those attributed to the second spermatotheca of *Doris*, that is to say, the spermatozoa when first received are probably combined in bundles or embedded in mucus, and it may be that when isolated and cleaned they collect in the bulges ready to descend into the oviduct. (3) Whereas in *Doris* both spermatothecas lie between the oviduct and the external orifice, in *Æ. papillosa* the duct from the exterior joins the oviduct, and close to this point of junction the spermatotheca arises out of the oviduct. One would suppose that this position makes it more difficult for the spermatozoa to reach the spermatotheca, but when they once have reached it they are very conveniently situated for fertilizing the ova as they pass down the oviduct. It is almost certain that the spermatozoa are detained for some time in the spermatotheca, and this seems to imply that they are expelled at the proper time by some movement of this organ. Probably the movement of the oviduct which causes the ova to descend also provides a stimulus which causes the muscular walls of the spermatotheca to contract.

It follows from the above that the Æolids and their allies are not diaulic *as a class*. Many distinguished authorities have stated the contrary but neither their descriptions nor their figures are sufficient to prove this generalization. The latter, numerous as they are, rarely show the relations existing between the various parts of the genitalia, but represent either isolated organs or else the genital mass in its natural compressed condition in which the connection between the various tubes is rarely plain. But Trinchese's figures of *Spurilla neopolitana*,[1] though not very clear, appear to indicate a structure like that here described for *Æ. papillosa*. There is little evidence to show how far this structure is common to Æolids, and much minute investigation is necessary before any general statement can be made. According to Hancock and Embleton the disposition of the organs in *Facelina coronata* is similar though not identical, but I have not been able to verify their statements either by dissection or by microscopic sections.[2] It seems probable that the less specialized forms in both the Clado- and Holohepatica (*e. g. Dendronotus* and *Melibe* in the one, *Tritonia* in the other) are truly diaulic, but that with increased specialization the triaulic condition is more or less completely developed.[3]

[1] Anatomia e fisiologia della *Spurilla neapolitana* Bologna, 1878, Pl. v, fig. 27.

[2] The investigation of the reproductive apparatus in Æolids offers great difficulty. Except in large animals the ducts are so small and fragile that their relations cannot be determined by dissection. On the other hand, the mucus and albumen glands when prepared for sectioning become so hard that it is sometimes impossible to cut them, and, even in the most favourable conditions, many sections become distorted or spoilt.

[3] It is only just to Bergh to say that he defined diauly and triauly as the presence of two or three external openings respectively. In that sense all known Cladohepatica appear to be diaulic. But other authors rightly emphasize the bifurcation or trifurcation of the hermaphrodite duct as the important point.

VII.

CLASSIFICATION.

The class Gastropoda, which is one of the principal divisions of the Mollusca, contains the two sub-classes Streptoneura and Euthyneura. The former are characterized by the torsion of the visceral mass and visceral commissure; they are nearly always diœcious and have only one pair of tentacles. The Euthyneura, on the other hand, are characterized by the detorsion of the visceral mass and commissure, accompanied by a marked tendency to concentration of the nervous system; they are without exception hermaphrodite and generally have two pairs of tentacles. They are divided into two orders—the Opisthobranchiata,[1] with aquatic respiration, and the Pulmonata (snails, slugs, etc.), which breathe air by means of a pallial cavity. The Opisthobranchiata are subdivided into the two sub-orders—Tectibranchiata[2] and Nudibranchiata. Those pelagic Mollusca which have sometimes been treated as a single group under the name of Pteropods, and sometimes as two groups, the Thecosomata and Gymnosomata, are now generally classified as families of the Tectibranchiata allied to the Bullidæ and Aplysiidæ respectively.

The Opisthobranchiata show such variety in appearance and structure that only a few general characters can be found applicable to the whole order. They are marine hermaphrodite Mollusca in which the ventricle is anterior to the auricle. They exhibit a tendency, which becomes very marked in the more specialized forms, towards external symmetry, reduction or suppression of the shell, and concentration of the nervous system round the œsophagus.[3]

The Nudibranchiata may be defined as marine hermaphrodite Opisthobranchiata without ctenidium and osphradium, and in the adult state, without a shell. The larva, however, has a shell and operculum. The visceral mass is not marked off from the foot (except in the Hedylidæ); the body shows complete or approximate external symmetry and usually bears plumes or other appendages which assist respiration. The nervous system is concentrated in a collar behind the buccal bulb, and the chief ganglia are placed on the dorsal surface of the œsophagus, being often partially united and sometimes fused

[1] Or Opisthobranchia.

[2] Also called Tectibranchia and Nudibranchia. Opisthobranch is strictly speaking opposed to Prosobranch, which is often used as equivalent to Streptoneura. But whereas the Streptoneura are almost without exception prosobranch, the word opisthobranch is not applicable to the Pulmonata and therefore not to the Euthyneura as a whole.

[3] *Acteon* does not conform to this diagnosis for it is streptoneurous and not an Opisthobranch in the literal sense of the words. But it is generally regarded as the most archaic of the Opisthobranchiata and allied to the Bullacea in virtue of its cephalic shield, buccal parts, and hermaphrodite genitalia.

into a single mass. The vas deferens is always an internal tube, never an external groove. Among other common but not universal characteristics of the Nudibranchiata are also the following: (1) The dorsal tentacles or rhinophores are often laminated and retractile, features not recorded in any other group. (2) The kidney is rarely compact, but usually a system of ramified tubes. (3) The genitalia are often extremely complicated, both in their essential plan and also owing to the presence of accessory glands and armatures. Besides this, the various sub-divisions show remarkable peculiarities of their own, such as the ramification of the digestive organs, the reduction of the radula to a single row, and the presence of nematocysts.

The Tectibranchiata are less easily defined. They show a tendency towards the features presented by Nudibranchs, but as a rule do not possess them in a complete form, or, at any rate, not all of them together. They often have a pallial cavity and external seminal groove, with a few exceptions they have, at least, a rudimentary shell, and with still fewer a well-developed ctenidium on the right side. It is the presence or absence of this latter and not of the shell which really marks the distinction between Tectibranchs and Nudibranchs. In the first the larva grows over its shell, and, even if the shell is totally absorbed, develops a ctenidium on the right side where a normal shell would have protected it, and this asymmetrical position of the ctenidium entails some asymmetry in the viscera. But in the Nudibranchiata the larva breaks its shell and grows without reference to the position of a possible shell: it develops, not a ctenidium, but symmetrically disposed gills of various kinds, and the whole structure, both external and internal, tends to become symmetrical. The only exceptions to the rule that the Tectibranchiata have a ctenidium are found among the Pteropods. Not only is the ctenidium often wanting in these families, but some genera (*Pneumoderma*, *Spongiobranchæa*, *Clionopsis*, *Notobranchæa*) have a posterior breathing organ homologous to the gills of Nudibranchs.

It may be asked if these forms should not be included among the Nudibranchiata. They certainly fulfil nearly all the conditions of the definition, the only exception being that they have an external seminal groove, but even apart from this groove the structure of their foot, parapodia, and head-parts separates them from the Nudibranchiata, and nothing would be gained by associating them more intimately with that group. But for all that, they indicate how easily the line between Tectibranchs and Nudibranchs may be crossed.

The Oncidiidæ, a family of littoral pulmonates represented on British coasts by *Oncidiella*, are also Nudibranchs according to the definition, and some forms (*e. g. Oncidium savignyi*) bear ramose processes on the back, which doubtless assist respiration. But the animals have also a pulmonary cavity, and a consideration of their whole anatomy leaves no doubt that they must be classed with the Pulmonata rather than with the Nudibranchiata.

A more debatable question as to the extent of the Nudibranchiata is raised by the Ascoglossa,[1] which in the opinion of some eminent authorities (Bergh, von Jhering, Brüel) form a separate group, characterized chiefly by the possession of a uniseriate radula in which the teeth have a special form, and do not drop off when worn out but are preserved in a sac

[1] Or Saccoglossa.

at the base of the buccal apparatus. In the opinion of the writers mentioned, the group consists (*a*) of *Lobiger* and *Lophocercus*, forming a small family of Tectibranchs known as Lophocercidæ, and provided with a shell, an internal vas deferens, and a laminated gill somewhat different from the ordinary ctenidium, and (*b*) of four families here classed as Nudibranchs, viz. the Hermæidæ, Phyllobranchidæ, Elysiidæ (including *Placobranchus*), and Limapontiidæ. These four families undoubtedly answer to the definition of Nudibranchs given above,[1] and in discussing their systematic position it will be most convenient to consider first the general classification of the sub-order and then to inquire whether there is sufficient ground for excluding them from it.

Although the name Ascoglossa, strictly speaking, denotes the whole group, including both Nudibranchs and Tectibranchs which certain authors wish to unite, I frequently use it in these pages as a convenient designation for the four families of Nudibranchs (Hermæidæ, Phyllobranchidæ, Elysiidæ including *Placobranchus*, and Limapontiidæ) which possess the ascoglossan radula.

Several primary divisions of the Nudibranchiata have been suggested, but the simplest plan is to make two tribes, the Holo- and Cladohepatica, those with entire and those with branched livers. This appears to me preferable to Pelseneer's division into four tribes, Tritonioidea, Doridioidea, Æolidioidea, and Elysioidea,[2] for these tribes are not equally important and distinct. Thus the Æolidioidea and Tritonioidea offer a greater contrast to the Dorids than to one another, and a distinction drawn between them may separate inconveniently forms which are closely related. For instance, *Notæolidia* has the appearance and most of the characters of an Æolid, but the liver is contained partly in the body-cavity, so that according to Pelseneer's system we must place it among the Tritonids and cannot show its close relationship to the Æolids. Even *Tergipes* hardly falls within the Æolidioidea if Pelseneer's definition ("the whole of the liver is contained in the integuments and tegumentary papillæ") is taken literally, for the digestive ducts in its body-cavity are lined with coloured liver cells. On the other hand, the Pleurophyllidiidæ cannot be classed simply as a family of the Æolidioidea, for their differences from that group are as great as their resemblances to it. The Elysioidea have many peculiarities in common but are distinctly cladohepatic, and it cannot, in my opinion, be maintained that the Hermæidæ differ from the Æolids as much as both of them differ from the Holohepatica. But the Æolids are connected with the Holohepatica by a long and continuous series of links, whereas the relatively small gap between them and the Hermæidæ is less completely bridged.

The Holohepatica are Nudibranchs in which the liver forms a compact mass, neither branched nor divided. This feature is usually (though with a few exceptions to each point) accompanied by the following characters: There is almost complete external symmetry, the vent being usually in the medio-dorsal line and surrounded by a circle of branchial plumes. Above the central nervous system is a double or single blood-gland.

[1] Bergh adds to the above definitions of the Nudibranchiata the following: *Lingua fortis, dentibus uni-, tri-, vel pluriseriatis apice linguæ paullatim caducis et eliminatis.* But these words are clearly added simply in order to exclude all Ascoglossa, and apart from their radula the four families come under his definition.

[2] Also called by him Tritoniomorpha, Doridomorpha, Eolidomorpha, Elysiomorpha.

The radula is usually of moderate or considerable width, and is not known to be reduced to a single tooth in any genus.[1] The labial cuticle often bears an armature of various kinds, but true mandibles are rare. The hermaphrodite gland is (with rare exceptions) not a separate mass but a layer spread over the liver. As a rule there are two receptacula seminis, and the genital ducts are triaulic. This is indicated externally by the presence of three openings, but the essence of the diaulic and triaulic arrangements consists not in the number of orifices but in the undivided or bifurcate configuration of the female branch of the genitalia. After the bifurcation the tubes may reunite before reaching the orifice.

The Cladohepatica are Nudibranchs in which the liver is branched or at least divided. In the majority of families it is contained wholly or mainly in the dorsal papillæ, into which its ramifications extend. Such papillæ containing liver branches are called cerata, and often bear cnidosacs. The vent is usually (but not always) on the right side. The gills assume various forms, but never that of a branchial rosette. There is no blood-gland. The hermaphrodite gland is an independent organ, and not attached to the liver. Mandibles are usually present, and the radula is frequently reduced to a single row of teeth. But the median tooth never disappears, and, in the uniseriate radula, is the only one that remains. The Holohepatica are (with the exception of the Polyceridæ) solidly built sluggish animals, usually of oval shape, and rarely bearing any processes larger than tubercles and branchiæ, but the Cladohepatica show great variety of form, and are often extremely elegant and active in their movements. They usually bear dorsal appendages, which may be very large.

The following table represents the classification of the Holohepatica here proposed.

Tribe I. Holohepatica.

Family 1. Tritoniidæ (*Tritonia*, *Marionia*, *Atthila*, *Tritoniella*, *Tritoniopsis*, etc.).
2. Doridoxidæ (*Doridoxa*).
3. Bathydoridida (*Bathydoris*).
4. Hexabranchidæ (*Hexabranchus*).
5. Doridida Cryptobranchiatæ (about fifty genera).
6. Doridida Phanerobranchiatæ with four sub-families.
   - α. Notodoridida (*Notodoris*, *Ægires*, etc.).
   - β. Polyceridæ (about twenty genera).
   - γ. Pseudoridida (*Acanthodoris*, *Adalaria*, *Lamellidoris*, etc.).
   - δ. Goniodoridida (*Goniodoris*, *Ancula*, *Idalia*, etc.).
7. Doridopsidæ (*Doridopsis*, *Doriopsilla*).
8. Phyllidiidæ (*Phyllidia*, *Fryeria*, *Phyllidiopsis*, etc.).
9. Corambidæ (*Corambe*, etc.).

Tritonia is to some extent a connecting link between the two tribes. Bergh classes it among the Cladohepatica while admitting its affinities to the Holohepatica, but it seems more logical to refer it to the Holohepatica (since it has a compact and undivided liver) while recognizing its affinities to some of the Cladohepatica. How real those affinities are is shown by the fact that its near relation *Marionia* (which must be regarded as a

[1] The narrowest known radula among the Holohepatica is in *Drepania* 1.0.1.

member of the same family) shows a division of the liver, one small portion being separate from the main mass, and has a stomach armed with horny plates. Besides this, the appearance of *Tritonia* recalls such forms as *Dendronotus* and *Lomanotus*; also it has no blood-gland, only one spermatotheca and a lateral anus, all features characteristic of the Cladohepatica. But, on the other hand, besides the undivided liver, it has the structure of the hermaphrodite gland (a layer on the liver) characteristic of Dorids, and its branchiæ are simply respiratory organs, not cerata. Also its buccal parts are very like those of *Bathydoris*, which, though an abnormal form, has no cladohepatic affinities.

Most Tritoniidæ have gills, but in *Tritonidoxa* and *Tritoniella* they are absent. Other gill-less forms are *Doridoeides* and *Doridoxa*. The first of these combines the characters of the Holo- and Cladohepatica, for it has the appearance of a Dorid (except that it has no branchiæ) and three genital openings, but its liver is ramified. *Doridoxa* (found in the northern Atlantic, and perhaps occurring off our northern coasts) has the shape of *Doris*, a blood-gland, and two spermatothecas, but there are no branchiæ and the anus is lateral. It appears to me probable that these genera, most of which combine characters that are not found united in ordinary forms, are survivals of some of the earliest types of Nudibranchs in which no new pattern of gill was developed to replace the ctenidium. In any case *Doridoxa* is a connecting link between the Tritoniidæ and Dorididæ, and the connection is further illustrated by *Bathydoris*,[1] which in general shape and many anatomical features resembles *Doris* but has the buccal parts of *Tritonia*. It is remarkable that it also has a hermaphrodite gland entirely separate from the liver; that is to say the connecting link presents an anomalous feature not found in either of the types which it connects, and suggestive of a different group.

The most important subdivisions of the Holohepatica are Dorididæ Phanerobranchiatæ and Dorididæ Cryptobranchiatæ. Both have gills in the form of plumes set in a complete or incomplete circle round the anal papilla, and may be called collectively Anthobranchiata. In the Phanerobranchiatæ the plumes, though sensitive and capable of contracting when touched, cannot be withdrawn below the level of the back into a permanent pocket[2]; in the Cryptobranchiatæ they can be retracted into such a pocket, which is often closed by teeth or tubercles, so that the gills entirely disappear.[3] Sometimes when the gills are large they can be withdrawn into the pocket only partially or with difficulty.

The phanerobranchiate Dorids exhibit great differences in both appearance and structure. In nearly all the sub-divisions there is a strong tendency to differentiate the

[1] *Bathydoris ingolfiana* is found in the north Atlantic.

[2] Phanerobranchiate gills usually shrink together when touched, and a hollow may be formed temporarily at their base and subsequently disappear. The characteristic of the Cryptobranchiatæ is a permanent pocket. Only rarely is it doubtful to which class a form should be referred.

[3] Bergh includes in the Dorididæ Cryptobranchiatæ *Bathydoris* and *Hexabranchus*, two genera which have no branchial pocket. If they must be classed in one group or the other they certainly belong to the Phanerobranchiatæ, but I think it is better to consider each of them as the representative of an independent family. *Bathydoris*, as already mentioned, has affinities to *Tritonia*. *Hexabranchus* is a tropical genus, which in many respects agrees with the typical Dorids, but its mouth is armed with strong labial plates, it has separate, non-retractile branchiæ, and is quasi-pelagic in its habits, being frequently found swimming at some distance from the land. The statement (repeated in the most modern manuals) that its branchiæ are retractile into separate cavities is not correct.

teeth of the radula and narrow its dimensions. With very few exceptions the blood-gland is single (usually double in the Cryptobranchiatæ) and the verge is armed with spines. The class may be divided into four families: (1) Polyceridæ; (2) Notodorididæ; (3) Pseudodorididæ; (4) Goniodorididæ. The Polyceridæ form a fairly numerous group and comprise many brightly coloured and graceful animals. They are usually elongate and often bear dorsal appendages. The analogy of the Cladohepatica suggests that there is some mechanical connection between these features, and that an elongate body can bear appendages better than a flat and oval one. It is not difficult to connect this group with those that we have already mentioned. Such an animal as *Polycera* resembles *Tritonia* in nearly all external features, except that the branchiæ, instead of being arranged along the mantle margin, are collected round the anal papilla. The mantle-margin is narrow and sometimes does not exist at all at the sides of the body, but over the head it is developed into an oral veil which often bears simple or branched processes (as in *Tritonia*). The rhinophores, which are nearly always perfoliate and retractile, are often provided with raised sheaths. The oral tentacles are generally small. Mandibular plates (hardly amounting to true jaws) are usually present. The tendency towards a narrow radula with differentiated teeth is very marked. In the Holohepatica this narrowing is always effected by the degeneration or loss of the outer teeth and the enlargement of the first few laterals or one of them, so that the radula reduced to its lowest terms (*Drepania*) becomes 1.0.1. In the Cladohepatica on the other hand, the reduction takes place by dispensing with the laterals and throwing all the work on the middle tooth, so that the minimum formula is 0.1.0. In *Trevelyana* the differentiation is slight, but the first tooth is often much larger than the others. In the other genera[1] some of the inner teeth are large and hamate, whereas the outer ones are reduced to flat plates. In *Euplocamus* and *Plocamopherus* we find radulæ like 12 + xi. 0. xi + 12, where the Roman figures represent hooked teeth and the Arabic ones plates. But in a large number of common genera there are only two hooked teeth, of which the second is the larger, and the radula varies from 12 + ii. 0. ii + 12 in *Triopa* to 2 + ii. 0. ii + 2 in *Polycerella*. Central teeth are rare, and when present (*Issa*, *Triopha*, *Nembrotha*) are, as a rule, imperfectly developed.

The Notodorididæ are a very small group comprising the three genera *Notodoris*, *Triopella* and *Ægires*, of which the last two inhabit the northern Atlantic. They are hard and stiff: the branchiæ are protected by special lobes or valves; the rhinophores are retractile and (except in *Triopella*) not perfoliate. There are no jaws in *Notodoris*, but in *Ægires* there is a single upper jaw, much as in the Pulmonata. The radula consists of simply hamate teeth, all alike and without any central tooth. This form of radula and the branchial valves approximate the Notodorididæ to the Cryptobranchiatæ, for the effect of the valves in protecting the branchiæ is much the same as that of a pocket.

I propose the name Pseudodorididæ for some genera with non-retractile branchiæ, on account of their resemblance to true Dorids, which is so great that in the letterpress accompanying Alder and Hancock's plates they are called *Doris*. They are flattish animals covered with small tubercles or papillæ. The parts round the mouth are dilated into a semi-circular veil on which tentacular appendages are hardly visible. The branchiæ, which may be pinnate or tri-pinnate, are contractile, but have no pocket.

[1] Except the very anomalous *Kalinga*.

Internally the buccal parts are characteristic. Above the buccal mass is a spherical or elongate muscular organ called the *ingluvies buccalis* or buccal crop. It is not known with any certainty how this organ (which is apparently suctional) acts, but its presence is nearly always accompanied by a great reduction in the width of the radula,[1] which presents a complete series of gradations. *Akiodoris* (one species from the northern Pacific) has no labial armature and has a radula consisting of two large hamate laterals with twelve or thirteen smaller teeth on either side. In *Adalaria* the arrangement is similar, but there is only one hamate tooth. In *Acanthodoris* there is a labial armature, and the radula is further reduced in breadth, not exceeding 8 + 1. 0. 1 + 8 in any species and often being much less. In *Lamellidoris* the labial cuticle is strengthened with rings and papillæ and the radula is 1 + 1 + 1 + 1 + 1 or 1 + 1. 0. 1 + 1. The median tooth when it exists is small. The first lateral is very large and hamate, the second merely a small plate.

All the genera of the Pseudodorididæ are closely allied to one another and are remarkable for being restricted to temperate seas. An interesting genus is *Calycidoris*[2] Abraham, in which the branchiæ are set in a depression, not amounting to a regular pocket. This arrangement seems intermediate between the Crypto- and Phanerobranchiatæ. Another remarkable form apparently referable to this group (or possibly to the Goniodorididæ) is *Ancylodoris baicalensis*,[3] a doridiform mollusc found in Lake Baikal. It is the only known example of a Nudibranch inhabiting fresh water, and appears to have approximated in some respects to the organization of the Prosobranchiata.

The Goniodorididæ are nearly allied to the Pseudodorididæ, but in external appearance resemble the Polyceridæ. Their buccal parts resemble those of the last family, but the radula is never more than 1 + 1.0.1 + 1, and in one genus, *Drepania*, sinks to 1.0.1. There is always a labial armature; oral tentacles are present, and the rhinophores are not retractile. This last feature is rare in the Holohepatica, and outside this family is known to occur only in *Bathydoris*[4] and a few Polycerids. It would be natural to regard it as primitive, but in some species of *Doridopsis* normally retractile rhinophores become non-retractile, and since it is clear that the buccal parts of the Goniodorididæ are highly specialized, the structure of their rhinophores may be secondarily acquired and due to disuse of the retractile powers.

There are about four genera. *Goniodoris* is somewhat elongate and bears ridges. In *Idalia* the mantle-margin is marked by a line of cirri. In *Ancula* and *Drepania* both the rhinophores and the branchiæ are protected by unbranched appendages, which compensate for the loss of pockets.

The Doridide Cryptobranchiatæ are, both in species and individuals, the most numerous group of Nudibranchs. More than fifty genera have been described, and some of them (such as *Platydoris*, *Discodoris*, and especially *Chromodoris*) have a great number of species. The common characteristic of all these forms is a branchial rosette completely retractile

[1] It is also found in Corambidæ (radula 4 + 1.0.1 + 4) and various forms with an ascoglossan radula, such as *Phyllobranchus*, *Placobranchus*, *Lobiger* and *Lophocercus*.

[2] See Eliot, Proc. Malac. Soc., 1907, pp. 359—360.

[3] See Dybowski, Deutsch. Malac. Gesellsch., 1900, pp. 143—152.

[4] See Eliot, National Antarc. Exped., Nat. Hist., vol. ii, Nudibr., p. 12.

into a permanent pocket. The rhinophores are invariably perfoliate and retractile. True mandibles are never present, but the labial cuticle is often armed with plates or a ring formed of hard elements. The radula is nearly always broad, and has rarely (*Cadlina*, *Tyrinna*) a central tooth. The teeth are not much differentiated. Occasionally (*Halla*, *Thorunna*, *Sphærodoris*) the first is larger and differently formed. A slighter differentiation is found in *Chromodoris* and some allied genera where the first tooth is rather broader than the rest and denticulate on both sides. The outermost teeth are often small and imperfectly formed; they are sometimes denticulate or divided into a bush of long hair-like spines. Occasionally (*Geitodoris*, *Rostanga*, *Jorunna*) a considerable number of teeth in the outer part of the rows are differentiated from the rest by being longer and thinner. Usually the teeth are simple hooks, all alike. More rarely (*e. g. Aldisa*, *Cadlina*, and especially the Chromodorididæ) all or some of them are denticulate. There is either a separate stomach outside the liver or else the liver-cavity acts as a stomach. There is always a blood-gland, and it is generally double. The hermaphrodite gland is a layer covering the liver, except in *Alloiodoris*, where it is separate. The vas deferens and verge are often armed with spines, which are sometimes very large and strong as in *Platydoris*; more rarely (*Kentrodoris*, *Peronodoris*) the verge terminates in a single stylet. There is sometimes a prostate on the upper part of the vas deferens, and various accessory glands may occur on both the male and female branches. The general shape is usually flattish and oblong with a mantle-margin of moderate or considerable width, but *Chromodoris* is more elongate with a narrow margin. The back may be smooth, granulate, villous, or covered with large or small tubercles of many kinds. Occasionally it is divided into areas by one or more ridges, and very rarely (*Echinodoris*) it bears tall papillæ.

The subdivision of this large class is a matter of great difficulty. The Chromodorididæ (including *Chromodoris*, *Casella*, *Ceratosoma*, *Thorunna*, but not, I think, *Aphelodoris*, with which Bergh unites them) form a natural group and so do the Cadlinidæ and perhaps the Kentrodorididæ. Some of the other genera, such as *Platydoris* and *Asteronotus*, offer distinct types. But in general it must be confessed that there is little certainty with regard to either the genera or groups of genera. As a rule the genera were first defined very precisely from a single species. But when it was subsequently found that other species did not quite conform to this diagnosis the definition was from time to time enlarged. The result is that the genera, originally too narrow, end by being too elastic, or that by modification of the original definition several genera become equivalent. Nor is this altogether the fault of the classification. The characters of which use can be made are not very numerous or important, and when the group has been thoroughly examined it will probably be found that they occur in almost all possible combinations. Also some of the characters are of doubtful value and consistency. Thus a labial armature is made by Bergh a generic and even a family characteristic (for the Discodorididæ). Yet it is sometimes allowed to be present or absent in the same genus, for it is found in *Platydoris variegata* Bergh and *Pl. tabulata* (Abraham) though absent in the other species. Again, *Diaulula* is separated from *Gargamella* simply by the character that the latter has an armature of spines on the male genitalia. But this armature is sometimes absent and sometimes present in animals ascribed to the same species, viz. *Acanthodoris pilosa*. I will not now discuss the general classification of the Cryptobranchiatæ further, for it can be

treated profitably only if the characters of all the exotic genera are analysed, a task which is hardly possible at present, and certainly does not fall within the scope of the present work. Of the British species which have been called *Doris*, the majority belong to the Pseudodorididæ, and we have only eleven species of true Cryptobranchiatæ. Five of these belong to the genus *Doris*, of which the type is *Doris verrucosa*. The remaining six represent a genus apiece. *Aldisa* has a tuberculate back, no labial armature, and denticulate teeth of unusual shape. *Cadlina* has a granulate back, a labial armature, a radula of denticulate teeth, with a median tooth occupying the rhachis. *Rostanga* is covered with minute hispid tubercles, and has simply pinnate branchiæ, a labial armature, and a radula containing two kinds of teeth. Those in the inner part of each half row are stout and hamate; those in the outer part are very long, thin, and bifid at the tips. *Jorunna* is nearly allied to the tropical *Kentrodoris*. The back is granulate: the branchiæ form a cup. The anterior margin of the foot is very deeply grooved and the upper lamina is developed into two ample lobes. The teeth are simply hamate, but the five outermost are long and thin. The other genera, *Geitodoris* and *Aporodoris*, offer greater difficulties, and cannot be regarded as certain. The first has a labial armature; the outer teeth of the radula are flat, and lie as if they were arranged in bundles. But *Doris testudinaria* has a somewhat similar arrangement. *Aporodoris millegrana* is discussed on pp. 106–107, and illustrates the difficulty one may have in referring a Dorid to its proper genus.

There remain three smaller groups, Doridopsidæ, Phyllidiidæ, and Corambidæ. The first two are confined to the warmer seas, and have neither jaws nor teeth, but in their place a suctorial tube. Except for this peculiarity *Doridopsis* is hardly distinguishable from the Dorididæ, and might be made a subdivision of them.

The Phyllidiidæ are superficially very unlike the Doridopsidæ. They are leathery animals elongate-oval in shape, and often ornamented with brilliantly coloured tubercles. The branchiæ are represented by a line of lamellæ running round the body under the mantle edge. The rhinophores are lamellated and retractile. The vent is usually dorsal: rarely (*Fryeria*) terminal and under the mantle-margin.

The Corambidæ are a very distinct group, but seem to be small in size and numbers. They are flat doridiform animals with retractile rhinophores, but the gills are represented by a few simply-pinnate lamellæ set at the end of the body under the mantle, on either side of the vent. The digestive apparatus appears to be as in the Pseudodorididæ. There is an *ingluvies buccalis*, a labial armature (though there is some discrepancy in the accounts of its shape), and a narrow radula (4 + 1. 0. 1 + 4). Only one spermatotheca has been found. This group seems to bear the same relation to the Phanerobranchiatæ as the Phyllidiidæ bear to the Cryptobranchiatæ. Each anthobranchiate class has parallel to it forms with the branchiæ under the mantle-margin.

The Cladohepatica, as here understood, form a large group exhibiting considerable differences of appearance and structure, for it includes the Æolidioidea and most of the Tritonioidea of Pelseneer, as well as the debatable ascoglossan families. All these forms agree in having the liver divided and generally ramified.[1] Very frequently it is contained

[1] The singular *Pseudovermis paradoxus* described by Kowalevsky is apparently a degenerate Æolid. It has lost its cerata, and the liver being obliged to occupy the body-cavity becomes a compact mass.

wholly in the dorsal papillæ. Occasionally (*Bornella*, *Scyllæa*, *Fiona*, *Tethys*, Pleurophyllidiidæ) there are special branchial membranes of various kinds, but as a rule respiration is conducted by dorsal appendages containing diverticula of the liver, or when these are absent, by the whole surface of the body (Phylliroidæ, Elysiidæ, Limapontiidæ). In the digestive apparatus jaws are nearly always present (except in *Hedyle*, *Tethys*, and the Ascoglossa). The radula is rarely broad (Pleurophyllidiidæ, most Janidæ, *Scyllæa*, and *Lomanotus*), very often it is reduced to three teeth in a transverse row (*Coryphella*, *Galvina*, etc.), and still more frequently to a single longitudinal series of teeth (all Ascoglossa, most Æolids). All Cladohepatica have a median tooth [1] and it never disappears as in the Holohepatica. The vent is usually (but with some exceptions) on the right side. The hermaphrodite gland is usually an independent mass and not a layer over the liver. As a rule there is only one spermatotheca, but there are two in many Ascoglossa and none at all in *Phylliroe*. The genital ducts appear to be diaulic in many genera. But it is rash to generalize on this point, for it is hard to determine the character of ducts and openings in small preserved specimens, and many species and genera of Æolids are known only by the examination of such specimens. In some species the spermatotheca is bifid, and though the external duct of the mucus gland (which corresponds to a uterus) is single, it is often divided by a fold so that the arrangement is practically triaulic. The arrangement in *Æolidia papillosa* has already been discussed.

The Cladohepatica show considerably greater variety in shape and structure than the Holohepatica, and may be divided into twenty-two families as follows:

Tribe II. Cladohepatica.

Family 1. Doridoeididæ (*Doridoeides*).
2. Pleurophyllidiidæ (*Pleurophyllidia*, *Linguella*, *Pleuroleura*, etc.).
3. Hedylidæ (*Hedyle*).
4. Dironidæ (*Dirona*).
5. Dendronotidæ (*Dendronotus*, *Campaspe*).
6. Scyllæidæ (*Scyllæa*, *Crosslandia*).
7. Bornellidæ (*Bornella*).
8. Tethymelibidæ (*Tethys*, *Melibe*).
9. Lomanotidæ (*Lomanotus*, *Hancockia*).
10. Phylliroidæ (*Phylliroe*, *Ctilopsis*, *Cephalopyge*, etc.).
11. Janidæ (*Antiopella*, *Janolus*, *Proctonotus*, etc.).
12. Notæolidiidæ (*Notæolidia*).
13. Æolididæ (numerous genera).[2]
14. Glaucidæ (*Glaucus*).
15. Fionidæ (*Fiona*).
16. Heroidæ (*Hero*).
17. Dotonidæ (*Doto*).
18. Myrrhinidæ (*Myrrhine*).

[1] But it is very difficult to see in *Lomanotus*, though present.

[2] It is highly probable that *Calma* should be excluded from the Æolidiidæ and made the type of a separate family.

19. Hermæidæ (*Hermæa*, *Stiliger*, *Alderia*).
20. Phyllobranchidæ (*Phyllobranchus*, *Cyerce*, *Caliphylla*).
21. Elysiidæ (*Elysia*, *Thuridilla*, *Placobranchus*).
22. Limapontiidæ (*Limapontia*, *Cenia*, etc.).

A few cladohepatic forms show an affinity to the Holohepatica. Such are *Dirona* and *Charcotia* in which the liver is trilobed but otherwise a solid mass. Their radula, however, is of the specialized cladohepatic type.[1] *Doridocides*, on the other hand, has the appearance of a Dorid and triaulic genital ducts, but its alimentary system is distinctly cladohepatic.

The Hedylidæ are a family of very uncertain position. Nominally they consist of a single genus *Hedyle*, of which Bergh has described one species from Flores, and Kowalevsky[2] four from the Black and Ægean Seas. But there are considerable differences between the species, for whereas *H. weberi* Bergh has only two tentacles and is definitely cladohepatic, Kowalevsky's species have four tentacles (except *H. milaschewitchii*) and the liver is not ramified, though it also seems not to be a compact mass as in the Holohepatica, but elongate and twisted. But in any case they differ from all other known Nudibranchs. The visceral mass is distinctly marked off from the foot; there are no branchial appendages; the skin is spiculous; there are no jaws and the formula of the radula is 2 + 1 + 2. The genitalia are imperfectly known, but the verge is armed with spines.

The remaining non-ascoglossan Cladohepatica may be divided into fifteen families, viz. Pleurophyllidiidæ, Dendronotidæ, Scyllæidæ, Bornellidæ, Tethymelibidæ, Lomanotidæ, Phylliroidæ, Janidæ, Notæolidiidæ, Æolidiidæ, Fionidæ, Heroidæ, Glaucidæ, Dotonidæ, Myrrhinidæ. It would be satisfactory to reduce this list, for it contains two groups of families corresponding roughly to Pelseneer's Tritonioidea (Nos. 5—10 on the table) and Æolidioidea (Nos. 13—18). But it seems natural and convenient to make the Æolidiidæ *sensu stricto* a family, and not to complicate the definition by including forms which do not exactly correspond to it. The Æolidiidæ *sensu stricto* are probably nearly as numerous as all the other Cladohepatica put together, and this being so the type becomes important and even its minor peculiarities deserve attention. But if we remove from the Æolids *Doto*, *Fiona*, *Hero*, etc., we cannot unite these forms into one family for each has its own characteristics. Again, Families 3—10 on the above list may very well be united into one group. But they also present marked differences, and if we divide the æolidiform animals into six families it would be inconsistent to lump these others in one. They must therefore, I think, be subdivided. But Families 5—10 and 13—18 may be recognized as forming groups or sub-tribes, and if it is thought worth while to give them names they may be known as Dendronotoidea and Æolidioidea.

The Pleurophyllidiidæ present such a singular combination of characters that they must be regarded as a group by themselves. They are moderately large animals, tongue-

[1] *Dirona* 2.1.2 and *Charcotia* 1.1.1. The affinities of *Charcotia* are very uncertain.

[2] "Les Hedylidés, étude anatomique." Mém. Acad. Pétersbourg (8) Phys. Math., xii, 1903. The figure of *Cylichna truncatula* given in Meyer and Möbius **1**, p. 87, suggests that like *Hedyle* it has a short foot and a visceral mass prolonged above and behind the foot, but as the animal has a shell it is not possible to be sure of the size of the soft parts.

shaped and resembling the Holohepatica in their general appearance and buccal parts. They have jaws and a wide radula which is practically that of *Tritonia*, but the teeth are denticulate. The rest of the digestive apparatus is as in the Æolids, that is to say, it is of the highly developed cladohepatic type. The liver is a layer of ramified tubes in the body-wall which unite and enter the stomach by three ducts. Cnidosacs are present in the mantle-margin and the branchiæ are represented by lamellæ under it. *Pleurophyllidia* thus combines the buccal parts of *Tritonia* with the hepatic system of *Æolidia* and the branchiæ of *Phyllidia*. It is a great difficulty to those who would make a phylogenetic tree of the Nudibranchiata.

There are about fifty species divided between four or five genera, of which the most important are *Pleurophyllidia* with branchiæ and *Pleuroleura* with none.

The six families grouped together as Dendronotoidea show traces of relationship to *Tritonia*, but the back usually bears a few large papillæ. The liver is usually contained partly in the body-cavity and partly in these papillæ, to which it sends branches, and there is considerable variation in this respect even in the same species (especially in the genera *Dendronotus* and *Bornella*). But even when there are no branches the liver is not as in the Holohepatica, but is divided into three (more rarely two) parts and is also more diffuse and flocculent. There is an oral veil, and the rhinophores are usually perfoliate and retractile into tall sheaths. The radula is generally of moderate width.[1] In *Tethys* there are neither teeth nor jaws; in *Melibe* no teeth but very feeble jaws. In this form (and also in *Scyllæa* and *Bornella*) the stomach is strengthened by a hard armature and is divided into two chambers. The arrangement of the hermaphrodite gland varies greatly, depending on the diffuseness of its own globules and that of the liver. In *Scyllæa* and *Phylliroe* it is divided into several (two to six) spherical packets. The male genitalia are armed only in *Bornella*.

The external appearance of these animals is very varied. *Dendronotus* and *Lomanotus* have somewhat the aspect of *Tritonia*, but the former has large arborescent cerata, and the latter a row of simple cerata set on its undulating mantle-margin. *Bornella* is an exceedingly elegant and active animal, somewhat resembling *Hero* in shape. It has branched appendages on the head and a few pairs of branched cerata which bear small gill-tufts. Similar gill-tufts occur in *Tethys* and *Scyllæa*. *Tethys* and *Melibe* look like gigantic Æolids with a great cowl or funnel round the mouth, which acts as a net to catch small crustaceans, etc. *Scyllæa* is semi-pelagic, living on floating seaweed. It has two pairs of very large cerata. *Phylliroe* is truly pelagic and modified in accordance with its life. It has no branchiæ or appendages of any kind except rhinophores, and the liver is reduced to four cæca which enter the stomach.

None of the six families are rich in genera or species, and when several genera are recognized in one family they are usually very similar. The families on the other hand are very distinct, especially in external appearance, and may be tabulated as follows:

A. Pelagic: No cerata.

1. Phylliroidæ.

B. Not pelagic: cerata present.

[1] In *Scyllæa* as much as 54.1.54, in *Lomanotus* 40.1.40, *Bornella* 19.1.19, *Dendronotus* 21.1.21 (but generally less). A few forms, such as *Hancockia*, have 1.1.1.

i. No stomach plates; no branchial tufts.
2. Cerata branched. Dendronotidæ.
3. Cerata not branched. Lomanotidæ.
ii. Stomach plates present. Branchial tufts present except in *Tethys*.
4. Two pairs of large cerata or a single pair of lateral wings. Scyllæidæ.
5. Several pairs of branched cerata; branched appendages near mouth; male genitalia armed. Bornellidæ.
6. Large æolidiform animals with several pairs of large cerata and a hood or funnel round the mouth. No radula. Tethymelibidæ.

Hancockia seems intermediate between *Lomanotus* and *Doto*, but may perhaps be included in one family with the former in virtue of the manner in which its cerata arise from the mantle-margin, the processes on its oral veil, and its perfoliate rhinophores. But the radula is 1.1.1.

There are a few forms which seem intermediate between the Dendronotoidea and Æolidioidea. They have most of the characters of the latter and are æolidiform in appearance, but they possess some features of the Dendronotoidea which prevent us from classifying them with the true Æolids, and none of them have cnidosacs. At the same time they show so little resemblance to one another that we cannot unite them in a single family. The Notæolidiidæ, represented by very large Antarctic nudibranchs, resemble the true Æolids externally in all particulars, including the presence of cnidosacs. But they have a hepatic mass in the body-cavity, as well as hepatic diverticula in the cerata and integuments, and the radula is 5.1.5. The Dotonidæ are small animals, bearing tuberculate cerata which resemble minute fir-cones. In structure they agree with the Æolids in most respects, but the rhinophores are retractile into sheaths, and though the radula is generally uniseriate, yet in *Dotilla* there are several small lateral teeth. These points connect them with the Dendronotoidea, but in others they seem more specialized than the Æolids. The ganglionic commissures are very short; the anal papilla is anterior and dorsal; the jaws are reduced and very thin. The Heroidæ, represented by the genus *Hero* only, have branched umbellate cerata, one pair of which is in front of the rhinophores. They cannot be placed with the Dendronotoidea, for the liver does not form a mass in the body-cavity, but is arranged in two longitudinal canals. In essential structure the Glaucidæ approach the true Æolids more nearly than the families mentioned, but they are specially modified for a pelagic life. The body is produced into three lateral lobes, and the cerata which grow out of these are directed not vertically but horizontally, so that they help the animal to keep its balance, if not to swim.

The Janidæ (*Antiopella*, *Janus*, *Proctonotus*) offer more complicated and perplexing affinities. The shape is æolidiform, but there is a crest between the rhinophores; the cerata (and consequently the hepatic ducts) pass round the front of the head. Besides sending branched prolongations into the cerata the liver forms a net-work in the integuments. The anal papilla is medio-dorsal and set far back. The radula consists of hamate teeth with a formula of about 40.1.40.[1]

Thus, like the Pleurophyllidiidæ, the Janidæ combine some of the characters of the

[1] According to Alder and Hancock (letterpress to Family 3, pl. 43) the genitalia show analogies to those of *Doris*.

Doridida (a broad hamate radula and medio-dorsal anus) with a hepatic system resembling that of the Æolidida though not identical with it. It is interesting to find that another genus (*Madrella*) which resembles the Janidæ in the arrangement of its liver-system and cerata has a triseriate radula and lateral anus. But it has rhinophores which are more like those of *Tritonia* than of any cladohepatic Nudibranch.

The true Æolids are almost as numerous as the Dorids, and, as they are often small and transparent, it is likely that a great many more remain to be described. The head bears tentacles (except in *Embletonia*) and rhinophores, which may be simple or perfoliate, but never have sheaths. On either side of the back are arranged cerata containing diverticula of the liver. They may be of various shapes, cylindrical, inflated, flattened, nodulous, etc., but are never branched. They usually bear cnidosacs in the tips. The foot is usually of the same breadth as the body, and the anterior corners are frequently produced into tentacular processes. Well developed jaws are always present. The radula is very narrow. It sometimes contains three teeth in a row; more frequently it consists of a single line of teeth. There is no compact or flocculent mass of liver in the body-cavity, but the core of hepatic substance in the cerata may extend more or less into the ducts, which finally enter the stomach by three openings. The male genitalia are often provided with spines, hooks, or accessory glands.

The Æolids are even more than the Dorids a very homogeneous group, in which it is difficult to find characters of taxinomic value. As such have been utilized the number and shape of the teeth, the shape of the jaws, the surface of the rhinophores (smooth, perfoliate, etc.), the conformation of the foot (round or angled), the shape and arrangement of the cerata, the armature and annexes of the genitalia. But these characters seem to be combined in all possible ways and none of them are absolutely satisfactory as a basis of classification. Thus the smooth or perfoliate surface of the rhinophores seems an important feature, but if we put together all the Æolids with perfoliate rhinophores the result is not a natural group; it simply shows that Æolids of all kinds may have perfoliate rhinophores. Further, the perfoliation may be perfect or rudimentary, and when it is rudimentary it is hard to distinguish it from a slight wrinkling often found in life (not merely in preserved specimens) in *Coryphella*, *Æolidiella*, and other genera, which are considered to have simple rhinophores. The least objectionable basis for classification is, I think, the number of teeth,[1] and I would divide the great bulk of Æolids into Triseriatæ and Uniseriatæ. This system is not without inconvenience, for it separates allied genera, such as *Flabellina* and *Pteræolidia*, which differ chiefly in the radula. But the character selected has this advantage, that the uniseriate radula is the more specialized of the two, and the triseriate radula points in the direction of the Dendronotoidea. Agreeably to this we find that, although we cannot say that all Triseriatæ have a primitive character, they at least include the form *Chlamylla*, which seems an annectent type such as

[1] I leave aside the question of classification based on the structure of the genitalia. In the last chapter I have shown that the genitalia of *Æolidia papillosa* do not conform to the diagnosis generally given for the family, and it is quite possible that the different genera of Æolids may exhibit considerable variation in these organs. But much difficult anatomical investigation is necessary before such variations can be tabulated or compared, and for present practical purposes this basis of classification is useless.

has not been discovered in the Uniseriatæ. It has a projecting mantle-margin and head-shield, and the liver forms a thick layer in the integuments beneath the cerata. *Himatella* too has a projecting margin. To this group may be added *Coryphella*, *Cumanotus*, and *Flabellina*, which all have denticulate laterals and a radula which is practically that of *Dendronotus* or *Notæolidia* reduced to three teeth. Another subdivision is formed by *Galvina* and *Capellinia*, which have inflated cerata, a strong central tooth, and broad but almost membranous side teeth. The radula of *Hancockia* is almost exactly similar and in a less degree that of *Hero*. The radula of *Chlamylla*, *Coryphella*, etc., is practically that of *Dendronotus* or *Notæolidia* reduced to three teeth.

The Uniseriatæ are a very large group, but offer only slight varieties of structure. They may perhaps be grouped by the shape of the teeth as well as by any other character. Of these teeth there are three types. The first and commonest has somewhat the shape of a horseshoe, bearing in front a median cusp and some accessory denticles at the side. More than twenty genera having such teeth have been described. In some the body is slender and elongate, *e. g. Facelina*, *Phidiana*, and *Hervia* (from which last *Rizzolia* seems to me indistinguishable). These three forms are similar in appearance but are clearly separated by the structure of their rhinophores, foot, and genitalia. Other genera are relatively short, and if not stout at least less slender. Such are *Cuthona*, *Amphorina*, *Tergipes*, and others. A few have special peculiarities. Thus *Embletonia* has rounded lappets on the head instead of oral tentacles.

The second type of tooth is broader than the first; the middle cusp is small or absent, and the whole tooth assumes the form of a curved row of denticles, often very numerous. This type appears to have been developed within the Æolididæ, and is not known outside the limits of the family. It clearly secures a broader denticulate surface. It is found in *Æolidia*, *Æolidiella*, and some allied genera which have a further common character in the possession of flat or compressed cerata. Perhaps *Phyllodesmium*, an Indo-Pacific form, should be placed here, as well as *Cerberilla* and *Fewrisia*. The third and rarest type of tooth consists of a single cusp with hardly any denticles or none at all.[1] It is found only in *Favorinus*, which is also characterized by having a bulb under the tip of the rhinophores. Perhaps *Moridilla*, which has only two lateral denticles and rhinophores studded with tubercles, should be placed here.

There remains one genus which has such exceptional characters that it requires a special sub-family which may be called Serratæ for its reception. This is *Calma*,[2] which is known to feed on fish-eggs. As a consequence, no doubt, of this unusual diet, the radula has atrophied and become a continuous but notched band of chitin. The digestive system is unusually broad and simple, as is also the kidney.

The following table shows the suggested classification of the Æolids. Only Atlantic genera are included. Those not recorded from British waters are in brackets.

[1] Observers are not agreed as to whether the teeth are minutely denticulate or smooth, but the disagreement is itself a proof that the denticulation, if it exists, must be extremely small.

[2] See p. 133 where I have explained that I regard this genus as consisting of *Calma* A. & H. + *Forestia* Trinchese, but without *Calma cavolini*. Researches into this genus made by Mr. Evans while this work was going through the press make it probable that it should be regarded as the representative of a separate family, like *Fiona* and *Myrrhine*.

A. Triseriatæ.

1. Lateral teeth usually denticulate:
   - [Chlamylla].
   - Coryphella.
   - Cumanotus.
   - [Flabellina].
2. Lateral teeth broad and membranaceous:
   - Galvina.

B. Uniseriatæ.

1. Horse-shoe teeth:
   - Facelina, [Phidiana], [Hervia] } elongate.
   - Cuthona, Amphorina } not markedly elongate.
   - Tergipes, Embletonia } cerata inflated.
2. Pectinate teeth:
   - Æolidia.
   - Æolidiella.
   - (Including Spurilla and Berghia).
3. Smooth teeth:
   - Favorinus.

C. Serratæ.

Calma.

The genus *Fiona*, which composes the whole family Fionidæ, has the liver arranged in two lateral canals and has branchial membranes on the cerata, analogous to the branchiæ of *Bornella* and *Scyllæa*, but forming a lateral lamina running along each papilla, not a series of tufts. The orifices of the male and female genitalia are separated by an interval. This resembles the arrangement found in the ascoglossan families.

The genus *Myrrhine* also must be allowed a family to itself. It was created by Bergh[1] for a large animal found in the Malay Archipelago, roughly speaking ælidiform in appearance, though even externally its leathery consistency and huge flat cerata are distinctive. It has no jaws, but a uniseriate radula of smooth teeth bifid at the tip and not unlike those of *Lobiger*. The genitalia are imperfectly known, but both the hermaphrodite gland and the kidney are diffuse and ramified throughout the body.

The four families known as Ascoglossa take their name from a peculiar form of radula which they all possess. It consists of a single row of somewhat spoon-shaped teeth, smooth or denticulate on the lower edge, which do not fall off as in most Nudibranchs but are preserved in a special sac. Very few teeth are in use at a time. None of the genera have jaws, but some have an ingluvies buccalis. The central nervous

[1] Siboga Expeditie, Opisthobranchia, 1905.

system usually consists of seven principal ganglia. The liver, the kidney, and the glands of the genitalia are all ramified, sometimes in a very complicated manner.[1] There are often two spermatothecas. As a rule there are three genital orifices and the genital ducts are completely or incompletely triaulic.[2] The follicles of the hermaphrodite gland are themselves hermaphrodite, and are not divided into male and female acini. The vent is usually dorsal; more rarely (*Phyllobranchus*) lateral. As a rule there is only one pair of tentacles (the rhinophores) or none at all.

It may be mentioned that the anatomy of all the Ascoglossa is exceedingly complicated and often varies in apparently allied species. The following characteristics of families are therefore given with all reserve.

The Hermæidæ are æolidiform animals bearing not very numerous cerata. *Stiliger*, in which the rhinophores are smooth and ungrooved, is externally indistinguishable from the true Æolids except by the absence of oral tentacles (which are also wanting in the Æolid *Embletonia*). In *Ercolania* the rhinophores are slightly furrowed. In *Hermæa*, *Placida*, etc., they are auriform. The anal papilla is usually dorsal and anterior.[3] The teeth are smooth or serrulate; there is no ingluvies buccalis. The stomach is small and lies transversely across the body-cavity. Into it enter two liver-canals,[4] one on each side, from which rise branches that sometimes form a layer of tubes in the integuments. They enter the cerata and ramify there, or more rarely (*Placida*) remain simple. There are two or three genital orifices and sometimes the male orifice is separated from the others by a considerable interval. The hermaphrodite gland fills the hinder part of the body-cavity. In some cases, at any rate, there are two *receptacula seminis*, and the genitalia have accessory ramified glands. The verge is armed with a spine.

In a formal classification it is perhaps simplest to include *Alderia* amongst the Hermæidæ, but it is a connecting link between them and the *Limapontiidæ*. In many points it is allied to the latter, but is dissociated from them by its cerata and the compact structure of its hermaphrodite gland. *Lobiancoia* Trinchese is described as having the general structure of *Hermæa*, but the diverticula of the liver do not enter the cerata. The Phyllobranchidæ are characterized externally by the possession of flat leaf-like cerata of unique appearance. They usually have grooved and bifid rhinophores as well as grooved tentacles. To the buccal mass is attached an ingluvies buccalis which is sometimes very large. The teeth are usually denticulate, and only two or three are in use at one time. There is a dilatation (proventriculus) before the stomach. Both the digestive and reproductive organs are extremely complicated; the latter are provided

[1] Something analogous to this ramification of the genitalia may be seen in the prostate of *Plocamopherus* (a phanerobranchiate Dorid) which is dendritic and surrounds the spermatotheca.

[2] But there is some divergence in the statements of various authors on these points. According to Pelseneer *Cyerce*, *Elysia* and *Limapontia* have one spermatotheca. In *Hermæa bifida* there are only two orifices; the prostate is ovoid and the albumen gland not ramified in the papillæ.

[3] In the somewhat doubtful *Hermæopsis variopicta* it is said to be lateral, but this has been contradicted.

[4] Both as to liver-canals and as to the genitalia there is considerable discrepancy in the statements of Bergh, Trinchese and Pelseneer.

with numerous accessory ramified glands, and the genital system is either completely or incompletely triaulic. The genera, though externally similar, present considerable differences of structure; thus in *Cyerce* the leaf-like appendages are merely tegumentary, whereas in *Phyllobranchus* and *Caliphylla* they contain branches of the liver. The family is recorded from the Mediterranean and Atlantic but not from British waters.

In the two remaining families, Elysiidæ and Limapontiidæ, there are no cerata and no appendages whatever except the rhinophores, which are sometimes much reduced. In the Elysiidæ the sides of the body are expanded into thin wings within which the subdivisions of the liver are profusely ramified, so that the arrangement is functionally similar to the cerata of other families. Also the afferent blood-vessels appear as threads or ridges on the dorsal surface. It does not appear to me that *Placobranchus* is entitled to rank as a separate family. Like *Elysia* it has wings, but they are folded more stiffly on its back, and it has an ingluvies buccalis. The Limapontiidæ are small slug-like animals without any special arrangements for respiration, which must be performed by the integuments generally. They frequent tide-pools and brackish water. They sometimes leave the water, and the abnormal development of *Cenia*, which issues from the egg in the adult form, is probably connected with this habit. Despite the difference in their external appearance the two families seem to be nearly related. A buccal crop is in both (almost invariably) absent, and the hermaphrodite gland is not a compact mass but a layer of diffused follicles. In the Elysiidæ the ramifications of the liver and the genitalia are more considerable, and are no doubt correlated with the greater space afforded by the lateral expansion of the body. In the Limapontiidæ the external symmetry is greater, for the vent is posterior and median, whereas in *Elysia* it lies in front of the pericardium and to the right. But in *Thuridilla*, which has in other respects the appearance of *Elysia*, it is terminal. This form has also a buccal crop. *Limapontia depressa* is flatter and wider than other members of the genus, and if the lateral expansions of the body were somewhat increased it would show much the same external configuration as *Thuridilla*. *Elysiella* and the *Bosellia* of Trinchese also show a transition towards the shape of *Limapontia*. *Alderia* is another annectent form, uniting some of the characters of *Limapontia*, *Elysia*, and *Hermæa*. It resembles the first inasmuch as the anal papilla is terminal and the rhinophores are reduced to rounded prominences. As in *Elysia* the sides of the body are developed into flaps, but these flaps bear cerata as in *Hermæa*, and, as in *H. bifida*, the genitalia open by only two orifices.

All the Ascoglossa show signs of specialization and none of them can be considered as archaic forms. The apparent simplicity of the Limapontiidæ is accompanied by such features as the posterior position of the anal papilla and two widely separated female orifices, so that their want of appendages is probably retrograde, not primitive. *Cenia* has even acquired a special larval history. On the other hand the Hermæidæ, especially *H. bifida*, present few features which cannot be paralleled among the Æolididæ and allied families. The radula of *Myrrhine* approximates to the ascoglossan type, as does also that of *Favorinus*. The jaws are very weak in *Doto* and absent altogether in *Hedyle weberi*, which is a cladohepatic Nudibranch, though of doubtful affinities. Anterior tentacles are absent in *Embletonia* and reduced in several other forms. The anal papilla is antero-dorsal in Dotonidæ. The male and female orifices are separated in *Fiona*. The kidney

and hermaphrodite gland are diffused in *Myrrhine*, more so it would seem than in the Hermæidæ. Although no Æolid presents seven principal ganglia in the nervous system like those of the Ascoglossa, yet *Rizzolia modesta* is stated by Bergh to have a ganglion on the visceral commissure, and this commissure bears ganglionic cells in other forms. As explained in the preceding chapter, the statement commonly made in text-books that all Æolids are diaulic is not correct. It is probable that further research will show that various forms of complete or incomplete triauly occur in both the Æolids and Ascoglossa. Therefore, I can see no reason in the present state of our knowledge for detaching the Ascoglossa from the Cladohepatica.[1]

We can now examine a question already alluded to, namely, whether the Nudibranchs with ascoglossan radulæ should be united with the two genera of Tectibranchs which possess the same peculiarity. These genera, *Lophocercus* and *Lobiger* (composing the family Lophocercidæ), have thin, globular shells partly covered by parapodia, a branchia of somewhat abnormal form,[2] a kidney composed of numerous chambers placed in the mantle above the branchia, a liver contained wholly in the visceral mass and not ramified, a nervous system consisting of six principal ganglia without gastro-œsophageal ganglia, and a genital system which, according to the accounts of both Bergh and Pelseneer, does not diverge materially from that of the Bullacea. There are two spermatothecas (as in many Bullids), and the vas deferens is an internal tube (as in *Aplustrum*), not an external groove. The buccal parts and œsophagus are similar to those of the nudibranchiate Ascoglossa, and the similarity is particularly striking between *Lobiger* and some Phyllobranchidæ, where the conformation not only of the radula but of the ingluvies buccalis and the gland on the œsophagus is almost identical.

The affinities of *Lobiger* and *Lophocercus* to the Bullacea are not, I think, denied. Such forms as *Newnesia*[3] and *Diaphana* are interesting connecting links, leading up to the ascoglossan arrangement. *Diaphana* differs from other Bullids in having no jaws or stomach plates and a triseriate radula. In *Newnesia* the structure of the alimentary canal is similar, but there is a diverticulum on the œsophagus and the radula is reduced to a single series of teeth. The teeth fit into one another but there is no ascus or ingluvies buccalis. Were these two organs added, the alimentary canal would be almost exactly as in *Lobiger*.

It might be difficult to discuss the resemblances of the Lophocercidæ to the nudibranchiate Ascoglossa if they depended on the details of the ramified organs in the alimentary and reproductive systems, for, as already hinted, the best authorities are not unanimous in their elucidations of these complicated arrangements. But this tendency to ramification and multiplication of glands is peculiar to the nudibranchiate section of the Ascoglossa. It has some analogies in other cladohepatic Nudibranchs, but none at all in the Lophocercidæ, and in fact constitutes one of the chief reasons for doubting their near

[1] Bergh, although he detached the Ascoglossa from the Nudibranchiata for taxinomic purposes, appears to have admitted that the Cladohepatica could be derived from the former. "Zwischen den Tectibranchien und den kladohepatischen Nudibranchien schieben sich als Bindeglied die Ascoglossen ein." System, pp. 995—996.

[2] It is a strap bearing lamellæ.

[3] See Eliot in Journ. of Conchol., 1905, pp. 312—5.

relationship to the Nudibranchiata. The important points of resemblance seem to be (1) the position of the genital orifices, (2) the nervous system, (3) the buccal apparatus, and in some cases the structure of the œsophagus.

In all the nudibranchiate Ascoglossa as well as in the Lophocercidæ, the male and female orifices are separated by an interval and are not contiguous as in most Nudibranchs. In the Lophocercidæ this certainly points to a previous condition in which the two openings were connected by a seminal groove (as in *Newnesia*), and the same explanation may hold good in the other families. But in them not only are the male and female orifices separated, but there are two female orifices which are also separated, sometimes by a considerable distance. This arrangement cannot be regarded as anything but extreme specialization, and taking the distribution of the three orifices as a whole it cannot be said to be primitive or reminiscent of the Lophocercidæ. On the other hand, in *Fiona* (which is not ascoglossan) the male and female orifices are separate.

The nervous system of the Lophocercidæ consists of six principal ganglia, and in the nudibranchiate Ascoglossa of six or seven. The arrangement is usually not quite symmetrical and appears to represent (1) a pair of cerebro-pleural ganglia intimately fused together; (2) a pair of pedal ganglia; (3) three visceral ganglia of which one (*e. g.* in *Limapontia*) may be suppressed. It is undoubtedly less specialized than the arrangement found in other Nudibranchs, and it approximates the ascoglossan families to the Tectibranchs. But at the same time it may be noted that the gastro-œsophageal ganglia characteristic of Nudibranchs are absent in the Lophocercidæ, but have been found by Pelseneer in *Cyerce*, *Hermæa*, *Elysia*; also that the presence of a rudimentary visceral ganglion in *Rizzolia* and in *Doris* approximates their nervous system to that of the Ascoglossa.

In its complete form the ascoglossan radula is found only in the families we are considering, but other molluscs have a somewhat similar arrangement of the buccal parts. Besides *Myrrhine* and *Newnesia* already mentioned, the Prosobranch *Homalogyra polyzona*[1] has a radula of uniseriate teeth fitting into one another, no jaws, and a buccal mass like that of the Ascoglossa, although the worn-out teeth are not preserved. In *Amphorina cærulea* and other Æolids where the radula is long and tapering the teeth are preserved, although there is no ascus. The small teeth (that is to say the early ones) remain on the under side of the tongue, which is literally tongue-shaped and not a mere cushion. Only those on the front part of the upper surface are used in eating, but the whole series persists, so that the radula exhibits unusual length and unusual disparity of breadth. If the under side of the tongue were enclosed by a membrane so as to form a pocket, this would be an ascoglossan radula. Further, it should be remembered that the buccal parts and in particular the radula may be almost identical in molluscs whose structure is otherwise very different; the Prosobranchs *Ianthina* and *Scalaria* have radulæ very similar to those of Dorids. *Aldisa* has teeth like those of *Berthella* (a Pleurobranchid), and *Kalinga* (a phanerobranchiate Dorid) like those of *Aplustrum*. No information is forthcoming as to the feeding habits of the *Lophocercidæ*, but some of the nudibranchiate Ascoglossa take nourishment by scratching or puncturing seaweeds and sucking the juice

[1] The structure of this animal has been disputed, but recently has been investigated by Vayssière, Ann. des Sci. Nat., Ser. Zool., xix, pp. 363—377.

set free by the wound. This operation requires only a few teeth which are employed in an unusual way, and not exposed to the wear and tear of breaking up food which may be spiculous. It is an intelligible (though certainly not a necessary) consequence of this mechanism that the teeth do not fall off, but that those in front are gradually covered up by the anterior tissues of the mouth-parts, and one can understand that this arrangement might be reproduced in molluscs not otherwise closely allied. Still these considerations should not blind us to the remarkable resemblance between the mouth-parts of *Lobiger* and the Phyllobranchidæ. But the fact that this resemblance is strongest in the family of the Ascoglossa least like the Lophocercidæ in other respects and most highly specialized in both external and internal structure, is an objection to giving it a phylogenetic significance, for I do not see how it is possible to derive the one family directly from the other. I am inclined to see in this resemblance an instance of a phenomenon to which I shall recur in the next chapter, namely that, in the Opisthobranchiata, forms whose general structure is very different may be found to exhibit the same structure in particular organs.

For taxinomic purposes it seems to me impossible to unite the Lophocercidæ and nudibranchiate Ascoglossa in one group and separate them from the Bullacea and Cladohepatica respectively, for they have more links with the groups from which we should separate them than they have with one another. And if we were to form them into one group, *à fortiori* we ought to unite *Pleurobranchæa* with the Doridida,[1] for their respective diagnoses[2] show hardly any difference, except the presence or absence of a ctenidium. But undoubtedly *Pleurobranchæa* is closely allied to *Pleurobranchus* which has a shell, and through *Pleurobranchus* to other Tectibranchs. Nothing, it seems to me, is gained by thus breaking down the distinction between Tectibranchs and Nudibranchs. It would, indeed, be most misleading to represent the latter as an independent group standing apart. On the contrary, all Nudibranchs are clearly derived from Tectibranchs, and all groups of Tectibranchs show members which are, so to speak, trying to become Nudibranchs. But for taxinomic purposes the line of division seems clear, viz. that Nudibranchs are Opisthobranchs which have neither a ctenidium nor a shell nor an external spermatic groove, and, as far as our present knowledge goes, this dividing line does not dissociate allied forms so much as would the removal of the Lophocercidæ from the Bullacea.

[1] As is proposed by Guiart, Mollusques Tectibranches in Causeries Scient. de la Soc. Zool. de la France, No. 4, 1900.

[2] I use this expression intentionally, for there are many details of structure which are not mentioned in the diagnosis, but indicate divergence.

VIII.

AFFINITIES AND RELATIONSHIPS.

The Opisthobranchiata, and indeed the whole subclass Euthyneura of which they form part, show a strong tendency towards reduction or loss of the shell, hermaphroditism, and detorsion, accompanied by concentration of the nervous system. It is generally agreed that the visceral torsion of the streptoneurous Gastropods is not caused by the coiling of the shell but that both are the result of early changes in the embryo. Detorsion however is very commonly associated with the reduction or disappearance of the shell. The Pterotrachæidæ, which belong to the normally streptoneurous group Heteropoda, are without shell and mantle and have also undergone detorsion. The Pulmonata have as a rule lighter shells than the Streptoneura and contain a much larger proportion of forms in which the shell is small, internal, or absent. It is clear that in its more advanced stage the acquisition of symmetry and of concentration in the nervous system is greatly assisted by the disappearance of the shell and the freedom thereby given to nearly all the organs to re-arrange themselves symmetrically.

Diminution or disappearance of the shell occurs in nearly all the great groups of the Mollusca. It would seem that these heavy coverings are felt to be a burden as well as a protection. Active animals can move more easily in lighter armour, while parasitic or sedentary animals which are sufficiently protected by their habitat often become obese and grow over the shell, enclosing it in their integuments. Among living Cephalopoda only *Nautilus* has a true external shell. In all the Decapoda it is internal and reduced; in the Octopoda it has vanished, leaving slight vestiges. The Aplacophora have no shell, though the mantle bears calcified spicules, and in several Chitons (*Cryptochiton* and *Cryptoplax*) the dorsal plates have become more or less covered by the integuments. It is hardly possible to imagine a shell-less Lamellibranch, for the structure of these animals depends largely on their being bivalves, but a few forms (*Chlamydoconcha*, *Scioberetia*, *Entovalva*) have overgrown and completely enclosed the shell, and in *Teredo* the long vermiform animal extends far beyond the small shell-valves, which only cover an insignificant portion of its length. In the Gastropods the shell sometimes becomes very small compared to the whole animal, without being enclosed. This happens in several pelagic Heteropods, in some active carnivorous Pulmonates (*Testacella*, *Daudebardia*), and in a few Opisthobranchs (*Cryptophthalmus*, *Smaragdinella*). More commonly the shell is overgrown by the mantle and becomes partially or wholly internal. This is very common among the Opisthobranchs and the Pulmonata Stylommatophora but hardly occurs among the Basommatophora. Among the Streptoneura partial covering of the shell is not infrequent, and it becomes wholly internal in several families, *e.g.* Lamellariidæ, Cypræidæ (*Pustularia*), Fissurellidæ (*Pupilia*). Finally the shell may disappear altogether as in many Opisthobranchs and Stylommatophora, and among Streptoneura in *Titiscania*, *Entoconcha*, and the Pterotrachæidæ. Sometimes the shell seems to be merely absorbed and the structure of the

animal is not greatly altered. Thus *Pleurobranchæa* and *Titiscania* do not differ materially from their shell-bearing relatives. But sometimes (presumably when the larva discards the shell before assuming its adult form) the whole organization undergoes a profound change. This happens in the Nudibranchs and also in the Pterotrachæidæ, which are evidently specialized Heteropods but have become euthyneurous and opisthobranch.

Hermaphroditism is not known to occur in the Cephalopoda, Scaphopoda, and Amphineura. Among the Lamellibranchiata it is not infrequent and prevails in the whole suborder Anatinacea. But its morphological importance is not great in this group, for, fertilization being always external, the organs affected are very simple. But in all hermaphrodite Gastropoda cross-fertilization is the rule and a complex apparatus is necessary. It might be plausibly argued that the prevalence of hermaphroditism in forms where the shell is absent or small, is due to the fact that they have a greater power of expansion and of finding room for extra organs. The few hermaphrodite Streptoneura partially support this view. They are (1) the Entoconchidæ, parasites with no shells (2) two genera of the Lamellariidæ, *Marsenina* and *Oncidiopsis* (3) *Bathysciadium* and *Cocculina*, both patelliform. There is also some evidence that *Patella* is hermaphrodite (4) *Valvata* which has a small shell and spreads considerably beyond it when extended (5) *Odostomia*. The last named and many Pulmonata have a spiral shell so that this conformation is not a barrier to the hermaphrodite condition, but it attains its greatest complexity in shell-less forms. It might have been supposed that, as the presence of two sets of sexual organs is in itself a considerable complication of the ordinary molluscan structure, the double apparatus would at least be as simple as possible. But on the contrary it shows a surprising power of development which in the more specialized forms results in luxuriant intricacy. Even the Tectibranchs exhibit considerable elaboration, for they may have a prostate, two spermatothecas, a mucus gland and an albumen gland. But in the Dorids and Ascoglossa in addition to all this the female branch of the genitalia bifurcates, to one portion being assigned the work of fertilizing the ova, to the other that of providing them with envelopes and depositing them as eggs. There are three genital orifices, and besides all this there may be present in one species an armature on both the male and female ducts as well as two or more accessory glands of unknown functions. Nor is it easy to see what is the object of this extraordinary elaboration, since the comparatively simple hermaphrodite apparatus of *Acteon* seems to serve its purpose equally well.[1]

In this and in many other points Nudibranchs show great specialization—as far as we can see, specialization for its own sake. They are one of the extreme branches of the molluscan tree, springing from the Tectibranchs but not giving rise themselves to any further offshoot. Yet a general survey of the extraordinary variety of forms which they offer does not suggest an effort to produce any culminating type but rather an inclination to give free play to several evolutionary tendencies and to encourage any variation which is not disadvantageous. The whole lineage of the Opisthobranchiata exhibits this proclivity to vary and to deviate from what seems at one point of the development to be its goal. A partial view of the Gastropoda suggests that the long series of successive modifications has for its object to encase a soft defenceless creeping animal in a strong

[1] The complexity of the nidamental glands, however, is not surprising, for the fertilized ova in the egg-ribbons of Nudibranchs may receive either singly or in groups as many as four envelopes.

spiral shell, but concomitantly with this arises an opposite tendency to dispense with the shell, and the representatives of this tendency, though not in the majority, form a very considerable proportion of the whole class. And just as we cannot say that the line of gastropod evolution moves towards one type, so the more specialized line of nudibranch evolution divagates and produces several types which are not successive developments or improvements but to some extent alternative or the antitheses of one another. When such alternative or antithetic arrangements occur, one may be more specialized than the other, but as a rule both appear to be equally effective, and the less specialized apparatus may be found in forms which otherwise are highly specialized.

Thus it can hardly be doubted that perfoliate or laminated rhinophores are an instance of great specialization. No complete parallel is found in any other Gasteropods, and, though many Bullacea have laminated rhinophorial organs, these take the form of laminæ arranged not on columns but on the flat sides of the head. Perfoliation of the rhinophores is almost universal among the Holohepatica and the less specialized Cladohepatica (*Dendronotus, Scyllæa*, etc.). But among the Æolids it seems to be present or absent indifferently, and this in all sections, for if we can draw distinctions among Æolids, *Chlamylla* and *Himatella* seem to belong to the less specialized, *Æolidia* and *Facelina* to the more specialized section. But in the two pairs mentioned the first genus has simple and the second perfoliate rhinophores.[1] Again, branchiæ may be present or absent without, it would seem, making much difference to the animal's general economy. Thus in the three pairs *Tritonia* and *Tritoniella*, *Pleurophyllidia* and *Pleuroleura*, *Tethys* and *Melibe*, the first genus has special gills, the second none. In the first two pairs, the forms with gills constitute the more abundant and successful type, but more species of *Melibe* than of *Tethys* are recorded. In the same way a prostate gland may be indifferently present or absent in similar forms which seem to get on equally well with or without it. Thus it is present in *Anisodoris*, absent in *Archidoris*, two equally flourishing and otherwise similar sub-genera of *Doris*. The branchiæ of the Dorids offer another instance, for they can be either simply pinnate or more extensively ramified, tripinnate plumes being very common. Both forms seem equally serviceable, and it is not clear why one should change into the other, except on the assumption that there is a natural proclivity to variation for its own sake. It might be supposed that the simpler structure would be found in the less specialized forms, but the branchiæ of such relatively primitive forms as *Tritonia* and *Bathydoris* are not simply pinnate plumes but arborescent tufts. And if we were to put together all the Dorids with simply pinnate plumes they would form a most heterogeneous assemblage exhibiting all degrees of specialization.[2] In some cases (*Doris verrucosa* and many species of *Chromodoris*) simple plumes occur in some varieties and scantily bipinnate plumes in others.

In this and many other more important cases it is difficult to say in which direction

[1] It is probable that perfoliate rhinophores without sheaths are a doubtful advantage, because the delicate organs are exposed to many accidents, but this does not explain why the sheaths are lost, nor why, when they are lost, the perfoliations are sometimes kept and sometimes not. Also, *Doto* has sheaths and smooth rhinophores.

[2] Simply pinnate plumes are recorded in *Doris verrucosa, Rostanga, Halla, Sphærodoris, Chromodoris* and its allies, in most Goniodorididæ, but among the Polyceridæ only in *Polycera* and *Polycerella*.

—simplification or elaboration—development is taking place. For instance, it can hardly be doubted that the branchial pocket of the Cryptobranchiatæ is a specialization, and that forms with the pocket are as a whole developed from those with none, though this need not mean that existing forms with a pocket are derived from existing forms with none. Yet change takes place in the inverse order. The Doridopsidæ are cryptobranchiate as a group, though the branchial pocket is often shallow, and *Doridopsis rubra* is normally cryptobranchiate as a species, but in individuals the pocket atrophies and the branchiæ become completely exposed and non-retractile.[1] The rhinophore pockets also atrophy in this species and they disappear in a few Polyceridæ and in all the Goniodorididæ. This last group seems to be in no sense primitive but rather an instance of extreme specialization. Yet it rejects the specialized retractile rhinophores common in the Holohepatica and converts them into simpler organs.

Again the structure of all other Gastropoda shows us that the ramified liver of the Cladohepatica must be regarded as a specialization, but in *Pseudovermis paradoxus*[2] a cladohepatic liver has become holohepatic, for in view of the animal's general structure it is hardly possible to regard it as an annectent type nearly related to the Holohepatica. In the ascoglossan genera, *Lobiancoia* and *Cyerce*, there is no compact liver-mass but the hepatic diverticula do not penetrate into the dorsal papillæ, and, as the animals are in most respects highly specialized, it seems probable that the diverticula have atrophied. Bergh's theory that the Holohepatica as a whole are derived from the Cladohepatica by a gradual concentration of the liver is not likely to commend itself as a general explanation, but such secondary concentration may have occasionally happened, as in the instances mentioned. Although the highly specialized arrangement of the liver found, *e. g.*, in Æolids diverges widely from the normal gastropod type, yet the same cannot be said of a liver which lies within the body-cavity but consists of two or three portions (*e. g.* in *Dirona* and such Dendronotoidea as have no hepatic diverticula in the cerata). For the commonest form of liver in the Gastropoda and indeed in the Mollusca generally is bilobed, and in the Fissurellidæ, which are usually considered an archaic family, there are three hepatic ducts. In so far as the liver of the Holohepatica is an undivided mass and opens into the stomach by a single duct it must be regarded as specialized. But the various genera of this tribe show considerable variety both as to the traces of division which the liver shows while remaining a solid mass and as to the number of ducts by which it communicates with the stomach. Similarly the general structure of the Gastropoda indicates that cerata are an instance of extreme specialization confined to a particular class, but on the other hand some facts suggest that these papillæ sometimes tend to become effaced, so that forms without them may be derived from forms possessing them. Thus the young *Lomanotus eisigii* has the appearance of an Æolid, but as it becomes older a membrane grows up between the bases of the papillæ and eventually they

[1] The phenomenon has been noted in living animals as well as in preserved specimens. See Eliot, in Linn. Soc. Journ. Zool., vol. xxxi, 1908, pp. 118—119. For a possibly similar instance in *Doris* see Eliot in Proc. Malac. Soc., vol. vii, 1907, p. 357, on *Staurodoris falklandica*.

[2] Kowalevsky, in Mém. Acad. Pétersbourg (8) Phys. Math., xii, 1901. I must confess that I cannot rid my mind of the suspicion that *Ps. paradoxus* is a larval form with abnormal sexual activity. Its relationship to *Ps. papillifera* (*sic*) is very remarkable and just what might be expected between two stages of a developing larva.

become little more than points on a lateral expansion of the back. So, too, in the young *Crosslandia*[1] the wings are bifid and subdivided but in the adult they become an undivided and roughly triangular flap. Hence account must be taken of the possibility that Cladohepatic forms without cerata have lost their cerata. All these instances (rhinophores, branchiæ, hepatic diverticula, cerata) illustrate the same principle as is seen in the loss of the shell. A special organ or form of an organ is developed; then variation begins in another direction and the peculiarities acquired by a group as a whole are lost by its more specialized members.

In considering the relationships of the Nudibranchiata, it must be remembered that we have no fossil forms and that none are likely to be found. In the Cephalopods about 400 living and 8000 fossil species are known. If the Nudibranchs have become extinct at about the same rate at least 20,000 species must have disappeared, and any attempt to relate existing genera to one another must be made with the knowledge that they probably represent a few specialized forms of the extinct host together with some chance survivals.

The principal recent authorities for the classification and phylogeny of the Nudibranchs are Bergh and Pelseneer. The system of the latter, as already indicated, ignores the difficulties presented by many genera, and the phylogeny corresponding to it is open to the same objection. It is not sufficient to represent *Janus* and *Pleurophyllidia* as side branches springing up together with the Æolids from a parent stock represented by *Dendronotus*. The perplexing thing is that these two genera share some of their characters with the Æolids, and the rest with various members of the Holohepatica. But for all that they cannot be regarded as unspecialized or annectent forms connecting the two groups. Bergh, who had a longer and more varied acquaintance with the Opisthobranchiata than any other zoologist, felt the difficulties of making any phylogeny, but the suggestions which he offered are not very clear or convincing. He considered that the Cladohepatica are connected with the Bullidæ and the Aplysiidæ through the Ascoglossa, and that the Holohepatica are connected with the Bullidæ through the Pleurobranchidæ.[2] This appears to be meant merely as a statement of resemblances, and not as an opinion that the origin of the Nudibranchiata is polyphyletic, for he also considered that the Æolids were derived from the Ascoglossa and passed into the *Tritoniidæ* and Dorids by a gradual reduction of their hepatic ramifications. But it is hard to believe that a highly specialized group (the Æolids) can give rise to a comparatively generalized group (the Tritoniidæ), and this again give rise to another and quite different highly specialized group. We have not and are never likely to have sufficient materials for delineating the family tree of the Nudibranchs, since we have no real knowledge of the trunk, still less of the root. The families which we know represent (to continue the metaphor) little more than the topmost boughs of a submerged forest which stand up above the water. Our data enable us to discuss profitably whether a clump of boughs belongs to one submerged trunk or to more than one, but only in the latest and highest branches can the points of origin and division be seen.

The line of division between the Holo- and Cladohepatica is undoubtedly to be found near the Tritoniidæ. This family is clearly annectent and shows how the two main types

[1] See Eliot in Linn. Soc.'s Journ., vol. xxx, 1908.

[2] Bergh **44**, p. 996.

of Nudibranchs can be variations of a single type. As mentioned in the last chapter, I think the family ought logically to be classed on the holohepatic side because its liver is not divided. But *Marionia*, indistinguishable externally from *Tritonia*, leans more to the other side, for it has a slight division of the liver, and, as in several of the Cladohepatica, the stomach is armed with plates. As might be expected there are several other annectent forms about the dividing line, mostly scarce and not well known. *Doridoeides* has the shape of a Dorid but a ramified liver, and *Dirona* in many characters resembles *Dendronotus* or the Æolids, but its liver is solid, although three-lobed.

It is easier to explain the Dorididæ as variations of one type than the Cladohepatica, but the number of plausible explanations is embarrassing and means of course that the facts which serve as sign-posts are few. *Bathydoris* and *Doridoxa* connect the Dorids with *Tritonia*, but opposite views have been held as to the relationship of the Crypto- and Phanerobranchiatæ. Bergh considered that the latter are derived from the former, and this order of development is supported by the case of *Doridopsis rubra* mentioned above and by the specialized buccal parts[1] of the Phanerobranchiatæ. But Pelseneer derives these latter from the Cryptobranchiatæ, and, as far as the structure of the branchiæ is concerned, this seems the probable order of evolution in most cases, though not without exception. He selects *Goniodoris* as the connecting link, but this seems to me improbable since this genus is in some respects highly specialized. I would rather suppose that some extinct form with differentiated teeth and in external characters resembling *Trevelyana* gave rise to *Chromodoris*, or that the Notodorididæ, which have simply hamate teeth and valves to protect their branchiæ, gave rise to some form like *Miamira*. But of the vast majority of existing Dorids it may be said that the Cryptobranchiatæ are more specialized in their gills and the Phanerobranchiatæ in their buccal parts, so that the one cannot be derived from the other, though both may be regarded as variations of a type like *Bathydoris*.

The suctorial Doridopsidæ may be explained as Cryptobranchiatæ with a modified buccal apparatus, in some respects analogous to that of the Pseudo- and Goniodorididæ but much more highly specialized. But they also resemble the Phyllidiidæ (especially *Phyllidiopsis*) which have the same suctorial mouth and branchiæ in the form of lamellæ under the mantle-margin. The Corambidæ have a similar arrangement of the branchiæ (especially analogous to the disposition found in *Fryeria*) but mouth-parts like those of the Pseudodorididæ. An analogous combination of infra-pallial branchiæ with a simply hamate radula has not been found, but an approximation to such an arrangement occurs in *Miamira*, which has normal cryptobranchiate gills, but also a mantle-margin produced into lobes bearing lamellæ on the lower surface. If this arrangement occurred in a *Doridopsis*, *Phyllidiopsis* might be evolved by suppression of the dorsal branchial plumes and extension of the lateral lamellæ.[2] But this form of respiratory apparatus involves a considerable change in the whole economy and it is also found in the cladohepatic *Pleurophyllidia*. It might therefore be reasonably argued that it must date from an early stage in the history of the Nudibranchiata when important characters could be modified or re-combined more

[1] In the great majority of genera we find either (1) differentiated teeth or (2) an ingluvies buccalis accompanied by a much reduced radula which usually exhibits two kinds of teeth.

[2] In *Phyllidiopsis berghii* there is a small circular cavity round the anal papilla which looks like the remains of a branchial pocket.

freely than now, and in support of this it might be urged that the simple renal organ of *Doridopsis* resembles that of *Tritonia*. In this case the resemblance between *Doridopsis* and the Phyllidiidæ would be due mainly to convergence.[1]

Of all these families there can be no doubt that the Cryptobranchiatæ are the most numerous and thriving. They number about three hundred out of a total of some five hundred known species of Holohepatica. This can only mean that the type of alimentary and respiratory organs which they all possess is eminently suited to animals of their habits. It may be observed that the branchial rosette of the Holohepatica seems to require and nearly always to receive some kind of special protection. The defence may take the form of (*a*) a pocket, (*b*) a valve closing over the branchiæ, (*c*) dorsal appendages near the branchiæ which keep off dangerous objects. When none of these are present the necessary protection may be secured by making the branchiæ very small with the greater part of the stem attached to the dorsal surface, or, on the other hand, by having the main stem of each plume very broad and strong (*e. g.* in *Nembrotha*) so that when it contracts it acts as a cover to the smaller pinnules which it bears. But of all these devices the branchial pocket is the commonest and most effective.

The Æolids form in the Cladohepatica an extensive and homogeneous group comparable to the Dorids. Being for the most part small and pellucid animals they are probably even more numerous than they appear to be, and will continue to furnish new species to the investigator. They can be derived from an ancestor like *Tritonia*, and a series of living forms, if not exactly connecting links, mark stages analogous to the line of development traversed. In the clumsy *Scyllæa* and more elegant *Bornella*, the structure of the Tritoniidæ (especially of *Marionia*) is still preserved in essentials. There are dorsal papillæ, but they are not wholly analogous to the cerata of Æolids. Branchial tufts are scattered over them, and they do not always contain diverticula of the liver, which consists mainly of two or three portions in the body-cavity. *Dendronotus* marks another step in the direction of the Æolids. The radula becomes narrower, there are no accessory branchiæ on the cerata, but the delicately ramified cerata act themselves as branchiæ. The liver still mainly consists of three portions in the body-cavity, and is sometimes ramified in the cerata and sometimes not, but in all cases is less solid and more flocculent than in the Tritoniidæ. *Lomanotus* is a parallel genus. It is farther from the Æolids than *Dendronotus*, inasmuch as it has a wide radula; nearer, inasmuch as its cerata are not branched but simple columns connected by a membrane. An antarctic genus *Notæolidia* effects the transition from these forms to Æolids like *Chlamylla* and *Coryphella*. One or two families diverge somewhat from this line of development, though not indicating another origin. The Phylliroidæ are specially modified for pelagic life. *Tethys* and *Melibe* are in some points of structure intermediate between *Dendronotus* and the Æolids, but their feeding habits have modified their alimentary organs, both internal and external.

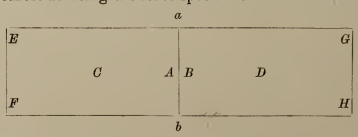
More difficult to explain than these are the Pleurophyllidiidæ and Janidæ. I do not see how it is possible to describe them as either ancestors or descendants of the Æolids,

[1] But side by side with differences there are many resemblances in anatomical details. In both families (1) the nervous system is so concentrated that the ganglia are hardly distinguishable; (2) the male genitalia are armed with spines; (3) there are folds on the wall of the pericardium—the so-called pericardial gill.

nor yet can they be dismissed as representing another line of development, for they possess some of the most highly specialized characters of the Æolids, such as the hepatic system (both), cerata (Janidæ), and cnidosacs (Pleurophyllidiidæ). With these characters they combine others which are either unknown or uncommon among the Cladohepatica. To represent adequately their affinities we require, not a linear arrangement, but a figure in three dimensions,[1] and if we wish to provide for them a plausible phylogeny, we must, I think, assume the existence of ancestors possessing combinations of characters now unknown but not improbable. There is no reason, for instance, why cnidosacs and the cladohepatic system which seems a necessary condition for them may not once have existed in animals shaped like *Doris* or *Tritonia*. It is easy, too, to find a reason for the disappearance of such forms, for cnidosacs are useless without a particular diet, and large numbers of Nudibranchs live on sponges and other animals which supply no cnidæ.

More or less parallel to the Æolids are a number of small families, some more, some less specialized, such as Fionidæ, Dotonidæ, Heroidæ, Myrrhenidæ. As with the Doridiдæ among the Holohepatica, so here we may conclude that the Æolids are the most successful of Nature's experiments in this branch of molluscan construction, but that other variations have a sufficient number of good points to maintain their existence. *Hero* is reminiscent of *Dendronotus*, but *Fiona* and *Myrrhine* (and *Doto* in some points though not all) foreshadow further developments and point in the direction of the Ascoglossa. Yet I find it hard to think that these latter are derived from the Æolids simply by a process of specialization, for the nervous system shows a different and apparently more primitive arrangement. But it seems impossible to dissociate *Hermæa* from the Æolids, and I should suppose that here, as in the Pleurophyllidiidæ and Janidæ, we meet with a collection of affinities which cannot be represented in a linear arrangement.

The Nudibranchiata may be imagined as filling an area divided down the middle by a line *ab* which separates the Holo- and Cladohepatica. *A*—*H* stand for the various types of structure, those nearest *ab* being the least specialized and those in the corners the most



specialized. Various special characters will be found common not only to *A* and *C* and to *B* and *D*, where there may be direct descent, or to *A* and *B*, which are near the dividing line, but also to *C* and *D*, *E* and *A*, *E* and *H*, and to many other pairs composed of two members whose structure is in other respects very divergent. Such combinations of characters are illustrated by the Pleurophyllidiidæ and other families already cited, but many other instances on a smaller scale occur. Thus the Holohepatica have the hermaphrodite gland as a rule in the form of a layer spread over the liver, but in *Bathydoris*, *Alloiodoris* (otherwise an ordinary cryptobranchiate Dorid), and *Trevelyana* (a Polycerid), it is collected in one or more solid masses, much as in *Scyllæa*. The verge is armed with

[1] As suggested by Sedgwick. See the diagram on p. 410 of his 'Students' Text-book of Zoology,' vol. i.

a straight spine (not a number of little spines) in a few Cryptobranchiatæ (*e. g. Kentrodoris*), in some Æolids (*e. g. Amphorina*), and some Ascoglossa (*e. g. Limapontia*), but not in the intervening forms. The tentacles are grooved in Tritoniidæ, some Dorids (*Platydoris* and *Doris*), and some Ascoglossa (*Cyerce*, *Phyllobranchus*). The kidney is a simple and unramified sac in *Tritonia* and *Doridopsis*. The nervous system is fused into a mass in which the ganglia are indistinguishable in the Tethymelibidæ (which are cladohepatic), in the Doridopsidæ and Phyllidiidæ, in *Hexabranchus*, and in a few ordinary Cryptobranchiatæ (*e. g. Asteronotus*). Some of these characters may be due to convergence caused by simplification or by concentration, but it will be observed that they do not depend on feeding habits or on the tendency towards external symmetry. Remarkable coincidences apparently due to these causes are seen in the ingluvies buccalis found in specialized Holohepatica (Pseudodoridiidæ, Goniodoridiidæ and Corambidæ) and in Ascoglossa (Phyllobranchidæ, *Placobranchus*, *Thuridilla*), and the terminal position of the vent found in similarly specialized but very different forms such as *Fryeria*, *Corambe*, and a few Ascoglossa (*Alderia*, *Thuridilla*, *Limapontia depressa*).

Nor do these instances of one or more remarkable common characters appearing to connect animals which are not nearly related in the rest of their organization occur only between Nudibranchs of different groups; they occur also between Nudibranchs and Tectibranchs, that is they extend to the whole group of the Opisthobranchiata. As already mentioned the Lophocercidæ and the Pleurobranchidæ are the families which approximate most closely to the Nudibranchiata, and the resemblances presented by the first named have been discussed. The Pleurobranchidæ are strikingly similar to the Dorids in many points, but these resemblances are divided among different genera and no one Pleurobranchid unites them or forms a connecting link. *Pleurobranchæa* is sometimes credited with this *rôle* because it has no shell, but in its less concentrated nervous system, its single genital orifice, its teeth, and even its external appearance, it resembles the Dorids less than does *Oscanius*, which, however, has an internal shell. The chief resemblances between Pleurobranchids and Dorids are the absence of the shell (*Pleurobranchæ*), the presence of spicules in the integuments, the general shape, the nervous system and sense organs, the presence of a blood-gland, the reno-pericardial tube, the radula, and the two spermatothecas.[1] The similarity in the nervous system is particularly striking. There are three pairs of large ganglia concentrated round and above the œsophagus, as well as smaller buccal and gastro-œsophageal ganglia; the commissures are generally short; the visceral ganglia tend to disappear from the visceral commissure; the osphradium is replaced by tentacular ganglia, and the eyes are buried in the integuments. On the other hand the stomach of the Pleurobranchidæ is in two divisions, the salivary glands are different from those of the Dorids, and the blood-gland lies on the heart, not on the anterior part of the aorta. It is also remarkable that the Pleurobranchids have more points in common with the Dorids than with *Tritonia*, which has a different shape, no spicules, no blood-gland, one spermatotheca, a median tooth, and different jaws.[2]

[1] But in some Pleurobranchids one of them is said to be imperfectly developed or absent.

[2] On the other hand, *Tritonia* has an oral veil and a lateral anus. The remarkably unspecialized character of *Tritonia* is shown by its affinities to both Holo- and Cladohepatica and also by the slightly asymmetrical disposition of its heart, which is evidently a vestige of the arrangement when there was a lateral ctenidium.

Yet *Tritonia* is more primitive than the Dorids, so that these latter and the Pleurobranchids must represent parallel, not successive stages of development. In external features at any rate the possibility of such convergence is certain, for not only Dorids and Pleurobranchids but also the Lamellariidæ and Oncidiidæ have the same general appearance.

But the resemblances between Tectibranchs and Nudibranchs are not confined to the Pleurobranchidæ and Lophocercidæ among the former, and many features characteristic of particular groups of Nudibranchs do not occur in those two families but in other Tectibranchs. In fact most of the peculiarities of the Cladohepatica may be found scattered among the Tectibranchiata, though not united in one form, and though the majority of the Cladohepatica can be explained as successive specializations of a type resembling *Tritonia*, the points in which they differ from *Tritonia* often prove not to be novelties but features occurring in the Tectibranchs, which as a group are less specialized than *Tritonia*. It may be useful to collect some instances where features characteristic of the Nudibranchs as a whole (*e. g.* nervous system, loss of shell, internal vas deferens), or of particular groups (*e. g.* divided liver, narrow radula, armature in genitalia) appear in Tectibranchs.

Taking the external characters first, the shell is entirely lost not only in *Pleurobranchæa* but in *Pelta* and in *Acclesia*, a genus of the Aplysiidæ. The perfoliate rhinophores of many Nudibranchs may be compared to the same organs in *Tylodina* which are lamellated internally, and also to the lamellated sense-organs of several Bullacea (most highly developed in *Haminæa* and *Aplustrum*), which though not tentacular seem to perform the same functions as rhinophores.

In the alimentary system the following points may be noted. The division of the liver is not entirely confined to the cladohepatic Nudibranchs, and (though unknown in the Pleurobranchids) occurs in other Tectibranchs. In some *Cavoliniæ* this organ is formed of two separate lobes, each with its own duct. In *Gastropteron* it consists of a number of small branched glands (about fifteen) which enter the stomach by separate ducts. The ramifications of these glands interlace with one another and with the lobes of the hermaphrodite gland. The liver also consists of three separate portions entering the stomach by separate ducts in the Oncidiidæ, an aberrant family of Pulmonates with affinities to the Tecti- and Nudibranchiata.

The broad radula of the Pleurobranchidæ resembles that of many Dorids, but narrow radulæ occur in other families of Nudibranchs and can be paralleled among the Tectibranchs. Thus a triseriate radula (1.1.1) occurs in *Pelta*, *Diaphana*, Thecosomata, and many Cladohepatica. The radulæ of *Philine* and *Scaphander*, in which there are only two large laterals with or without a small median tooth (1.1.1 or 1.0.1), resemble that of the Goniodoridiidæ, and the radula of *Cylichna* (a central tooth with one large lateral followed by two to five small ones) shows some analogies to that of *Adalaria*. The Bullid *Newnesia* has a uniseriate radula. Teeth are entirely absent in Doridopsidæ and Phyllidiidæ (Holohepatica), Tethymelibidæ (Cladohepatica), *Doridium* and *Retusa* (Bullacea). Most remarkable is the occurrence of an upper unpaired jaw similar to that of the Pulmonata in *Ægires*, a phanerobranchiate Dorid, and *Bullastra*.[1] In the Gymnosomata, jaws when present are fused to-

[1] This very obscure form is regarded by Bergh (Mal. Unters., iv, 3, 1901, p. 254) as belonging to the Bullacea. It seems to me as if it might be equally well regarded as an aberrant Pulmonate. But

gether below. Stomach-plates or spines which do not occur in either the Pleurobranchidæ or Lophocercidæ are found in most Bullacea, the Gymnosomata, Aplysiidæ, and among Nudibranchs in the Tethymelibidæ, Scyllæidæ, *Bornella*, and *Bathydoris hodgsoni*. In some species of *Aplustrum* too (*A. physis*, *A. velum*) the mandibles form a ring or band analogous to the labial armature of many Dorids.

The central nervous system is concentrated in *Notarchus* and *Acclesia*, the visceral ganglia being drawn up between the pleural ganglia and the visceral commissure being shortened. Concentration (varying in degree in the different genera) also occurs in *Gastropteron*, *Aplustrum*, *Umbrella*, *Tylodina*, and the Pleurobranchidæ. A blood-gland is found in these last and in most Holohepatica; also in *Bulla*, *Aplustrum*, *Scaphander*, *Philine*, and *Akera*.

In the genitalia, an external spermatic groove is usual among the Tectibranchiata, but a curious combination of genera replace it by an internal vas deferens: *Acteon*, *Aplustrum*, Lophocercidæ, *Umbrella*, *Tylodina*, and Pleurobranchidæ. In these last and in *Aplustrum* the orifices are contiguous, as in most Nudibranchs. In *Acteon*, the Lophocercidæ, *Fiona*, *Calma*, and the ascoglossan Nudibranchs, they are separate. Most Tectibranchs have two spermatothecas, but *Acteon* and *Gastropteron*, like the Cladohepatica (except some Ascoglossa), have one. The Thecosomata and Gymnosomata have also only one or none at all, like *Phylliroe*. A chitinous armature of the male genitalia, such as is common in Nudibranchs, is not recorded in the Pleurobranchidæ but is frequent in the Aplysiidæ, where it appears as numerous simple spines or chitinous hooks set upon softer prominences. In *Diaphana* and *Bullacta* the verge is armed with a single spine or hook as in some Æolids, *Kentrodoris*, etc. In *Scaphander* the configuration of the hermaphrodite gland is almost the same as in some Dorids. It is spread over the surface of the liver and sends prolongations into it. The structure in *Akera* appears to be similar.

Thus many important characters common to the Dorids and Pleurobranchidæ are also found in other Tectibranchs. Such are the absence of a shell, concentration of the nervous system round the œsophagus, an internal vas deferens, and a blood-gland. Other characters are found in several Nudibranchs and Tectibranchs but not in the Pleurobranchidæ. Such are an armature of the stomach, an armature of the genitalia, very narrow radulæ, lamellated sense organs on the head, a liver in several divisions. It would seem that when one group of animals (here the Nudibranchs) is derived from another (here the Tectibranchs), and some families of the parent group approach so near to some families of the derived group that they may be regarded as annectent, then the derived group may exhibit not only the characters of the annectent families and others that may be supposed to have grown out of them, but also characters not found in the annectent forms at all but distributed among other members of the parent group. This may be explicable by the disappearance of extinct forms, which leaves us with a very limited and inadequate notion of the extent to which characters may have been combined in the past. It is also possible that an annectent form may transmit not only its own characters but the potentiality of other characters existing in distant members of the group to which it belongs. Among the Tectibranchs not only the Pleurobranchidæ and whatever the affinities of *Bullastra* may be, the fact that *Ægires*, alone of all Nudibranchs, has a jaw like a pulmonate, remains.

Lophocercidæ (especially the former) approximate to the Nudibranchs, but also the Gymnosomata as well as *Acclesia* and *Aplustrum*. These two genera each unite several features which are either common to all the Nudibranchiata or characteristic of some of them. Thus *Acclesia* has (1) no shell, (2) a concentrated nervous system, (3) a radula roughly resembling that of *Cadlina*, (4) mandibular plates roughly resembling those of *Hexabranchus* or *Chromodoris*, (5) stomach-plates, (6) an armature of the genitalia. *Aplustrum* has (1) an internal vas deferens, (2) teeth rather like those of *Kalinga*, (3) mandibular plates like the labial armature of many Dorids, (4) a blood-gland, (5) pinnate rhinophorial organs, (6) a concentrated nervous system.[1] These genera cannot be said to be on the border-line between Tectibranchs and Nudibranchs, but if we let our fancy play with extinct forms (an easy and not very profitable speculation), a short and plausible series might be imagined leading from either of them to true Nudibranchs. Land slugs are known to be polyphyletic, and there is no objection to admitting the same origin for our group except that certain forms bring divergent subdivisions (such as Clado- and Holohepatica, Ascoglossa and Æolids) so near together that the hypothesis may be superfluous. Those who have kept count of the new types discovered in the last fifteen years will not be surprised if more annectent genera are discovered. But if a polyphyletic origin is required to explain the facts, I should be disposed to imagine not that such dissimilar creatures as the Lophocercidæ and *Phyllobranchus* are united by direct descent, but that there was once a whole series of forms roughly analogous to *Tritonia* but possessing characters which at present survive only in relatively primitive Tectibranchs and highly specialized Nudibranchs. Nor do I think we have any right to assume that it is only the more specialized Tectibranchs which have produced even more specialized descendants in the Nudibranchs. Even *Acteon*, the very root of the opisthobranch tree as it is commonly drawn, is not unlike the Nudibranchs in its buccal organs and genitalia.

The affinities of the Oncidiidæ to the Tecti- and Nudibranchiata are also worth notice. They must be regarded as Pulmonates for they have the pulmonary cavity characteristic of this group, with which they also agree on the whole in the structure of the genitalia and kidney. But they also present the following features: (1) The shell is entirely absent. (2) Besides pulmonary respiration on land they are also capable of aquatic respiration in the water. This is performed by the integuments which in some species of *Oncidium* bear dorsal tufts resembling the branchiæ of Dorids. (3) They are opisthobranch, the gill lying behind the heart. (4) The liver is in three portions, opening into the stomach by separate ducts. (5) The stomach consists of three or four divisions, the first with thick walls and chitinous plates. (6) The verge is armed with numerous small spines. (7) The nervous system is concentrated round the œsophagus and consists of five ganglionic masses, the cerebro-pleural (fused) and pedal pairs and an unpaired visceral ganglion. These resemblances have been explained as convergences, on the supposition that the Oncidiidæ are specialized Pulmonates which have taken to marine life, but it is hard to see how this could affect the structure of the liver or genitalia. Plate is therefore probably right in regarding them as a very early branch of the Pulmonates, thrown off at a time when it was possible to combine pulmonate characters with those of the Opisthobranchiata.

[1] Known best in *A. albo-cinctum*.

DESCRIPTIONS OF THE SPECIES.

The species which form the subject of the following notices fall into three classes. First those figured in the drawings preserved at Newcastle. These are sixteen in number, namely *Doris testudinaria*, *Aldisa zetlandica*, *Adalaria lovéni*, *Lamellidoris ulidiana*, *Crimora papillata*, *Lomanotus genei*, *Hero formosa*, **Janolus hyalinus*, *Doto cuspidata*, *Embletonia pallida*, *Amphorina cærulea*, **Cuthona* (*?*) *northumbrica*, *Cuthona* (*?*) *inornata*, **Alderia modesta*, *Elysia viridis*, *Limapontia depressa*. The three species marked with an asterisk are already figured in the Monograph but the drawings now reproduced give further details. The second class comprises eleven species which are not described in the Monograph. They are *Doris verrucosa*, *Doris maculata*, *Pleurophyllidia lovéni*, *Cumanotus beaumonti*, *Cenia cocksi*, *Hancockia endactylota*, *Doto cinerea*, *Coryphella salmonacea*, *Stiliger bellulus*, *Acteonia corrugata*, *Limapontia nigra*. Four of them are illustrated by figures drawn from living animals in the last two years, chiefly at Plymouth. Most of these forms have been added to the British fauna since the time of Alder and Hancock, but a few of them are mentioned in their later works. The third class consists of seven species mentioned in the Monograph about which additional information is now furnished. These are *Tritonia alba*, *Geitodoris planata*, *Dendronotus lacteus*, *Doto pinnatifida* (three varieties), *Eolis angulata*, *Calma glaucoides*, *Aporodoris millegrana*.

TRITONIA ALBA A. & H.

(Plate I, fig. 10.)

See Monograph, part vii, p. 48, and Appendix, p. vi; and Eliot **1**, p. 335.

Specimens of this form were found by Alder and Hancock at Cullercoats, near Newcastle, and described by them as having considerable external resemblance to young individuals of *T. hombergii*, but as differing in dentition from all known Tritonias, inasmuch as the lateral teeth were denticulate or branched. Bergh (**40**, pp. 734 and 736) rejects the species as doubtful, and thinks that the denticles were merely an illusion of the microscope. An examination of the original specimens preserved in the Hancock Museum at Newcastle-on-Tyne has shown me, however, that this is not the case, and that the teeth are really denticulate.

The two specimens are respectively 7 mm. and 6 mm. long, and 2·8 mm. and 2·2 mm. broad. One is dark brown, the other yellowish. The hard buccal parts are fortunately

well preserved; but few other characters either external or internal can be established, which is hardly surprising, as the specimens must be at least fifty years old. There is no reason, however, to doubt the accuracy of Alder and Hancock's description. The dorsal margin is large, and seems to have borne in the one specimen six, in the other eight branchiæ of various sizes. No trace of stomach plates was found.

The jaws are yellow, rather long and narrow, and bear near the edge about four rows of small prominences resembling a mosaic. The radula is very transparent, and consists of twenty-five rows, which appear to contain thirty-six teeth on each side of the rhachis when complete. The rhachidian tooth is tricuspid, and hollowed out below. The first lateral is of the usual clumsy shape, but is rather variable in outline. The second lateral is smooth, moderately stout, and simply hamate. The succeeding teeth become longer and slenderer towards the outside. The third lateral bears a prominence or rudimentary denticle, and the remaining laterals in the middle of the half row bear from one to three long branch-like denticles, and sometimes one or two accessory shorter ones. Towards the end of the row the denticles are found only at the tip of the teeth, and the outermost are elongate and bifid. This peculiarity is not marked in Alder and Hancock's plate, which otherwise gives a very accurate representation of the radula.

DORIS L.

In compliance with the nomenclature introduced by Bergh, the common British *Doris* is generally described as *Archidoris tuberculata*, and another form which is rare here though frequent in French waters as *Staurodoris verrucosa*. I submit however that this nomenclature is not correct, and that the Linnæan name of *Doris* ought to be restored.

Bergh (Mal. Unt. in Semper's Reisen, xiv, p. 616) decided to discontinue its use ("besser wäre es, wie hier geschieht, den Namen Doris als generische Bezeichnung ganz zu streichen"), but there are at least two objections to this course. Firstly, if an old genus is divided into several genera, one of these new genera should, according to the rule generally recognized, bear the name of the old genus. Secondly, it would appear that in *Staurodoris verrucosa* Bergh, the use of the specific name really admits that the animal is the Linnæan *Doris*. The type of *Doris* is *Doris verrucosa* of the tenth edition of the 'Systema Naturæ.' It is true that the animal cannot be recognized from Linnæus's description, but Cuvier identified it rightly or wrongly with a Mediterranean form, and Cuvier's animal has been renamed *Staurodoris verrucosa* by Bergh. But this form can bear the specific name *verrucosa* only on the supposition that it is the *Doris verrucosa* of Linnæus. Therefore either it is *Doris verrucosa*, or else *Staurodoris* with a new specific name; but it cannot logically be *Staurodoris verrucosa*.

Further, it seems a pity to abolish a well-known name employed by so many eminent naturalists, and in my opinion the use of *Doris* is not only correct but convenient. I cannot help thinking that the distinctions between Bergh's genera of the Archidorididæ are somewhat minute, and that a juster classification would be secured by the use of the genus *Doris* (type *Doris verrucosa*), to include as sections or sub-genera at least *Staurodoris*, *Archidoris*, *Anisodoris*, and possibly others.

Staurodoris Bergh cannot be satisfactorily separated from *Archidoris* Bergh, as the two genera are connected by their less typical members. The typical *Staurodoris* has simply pinnate branchiæ and the back studded with clavate tubercles, which form valves round the rhinophores and branchiæ. But in the less typical form the branchiæ become bi- or tripinnate and the valvular tubercles less distinct.

The genus *Doris* as restored must consist of *Doris verrucosa* and such forms as can be considered as belonging to the same genus. There may be considerable difference of opinion as to how much these words include, but I would suggest for present use the following definition and division.

Cryptobranchiate Dorids which are moderately soft and moderately flat. Dorsal surface warty or tubercular. Tentacles often thick and grooved. Foot and mantle-margin, as a rule, moderately broad. No armature on the labial cuticle or male genitalia. Radula broad with no central tooth and numerous simply hamate laterals.

This definition is meant to exclude forms with a smooth or villous back, denticulate teeth, and other peculiarities. A rudimentary armature of the labial cuticle seems to occur occasionally, and it may be doubted if its presence in a fully developed condition would justify us in excluding a species if otherwise possessing the generic characters. The same may be said of the armature of the male genitalia.

Section 1. *Staurodoris* Bergh, which must also be considered as *Doris sensu stricto*. Dorsal tubercles large and club-like, sometimes connected by ridges and specially developed so as to protect the branchiæ and rhinophores. Branchiæ usually rather scanty and often simply pinnate. Type: *Doris verrucosa*.[1]

Section 2. *Archidoris* Bergh. By reduction of the dorsal tubercles and amplification of the branchiæ *Staurodoris* passes imperceptibly into *Archidoris*, and forms on the border line can be referred to either genus.[2] The type of these forms with tripinnate branchiæ and moderately large tubercles which are not specially developed to protect the branchiæ and rhinophores is *Doris tuberculata* Cuv.

Section 3. *Ctenodoris* Eliot. This exotic genus has most of the characters of *Archidoris* but the branchial plumes are simply pinnate and arranged in a crescent. The upper lip of the branchial pocket shuts down upon this crescent like a single valve. The type is *Doris flabellifera* Cheeseman (1880) from New Zealand.

Section 4. *Anisodoris* Bergh (synonym *Montereina* MacFarland) comprises exotic forms which have the external characters of *Archidoris* and differ only in the presence of a prostate on the male genitalia. Type *Doris punctuolata*.

Section 5. *Homoiodoris* Bergh has like *Anisodoris* the external characters of *Archidoris* and a large prostate but also an armature of plates on the vagina. The type *Doris japonica* Bergh is common in Japan.

[1] A. and H. on p. xvii of the appendix to part vii suggest that *D. verrucosa* belongs to Ehrenberg's genus *Glossodoris*. But apart from the fact that this species is Linnæus's type for the genus *Doris*, and therefore not transferable from that genus, it is probable that *Glossodoris* is a synonym for part of *Chromodoris*.

[2] E. g. *Staurodoris pseudoverrucosa* von Jhering has large bipinnate branchiæ and no tubercles round the branchial pocket. *Archidoris australis* Bergh has "nodules" round the branchial and rhinophorial pockets, and eleven slender branchiæ, simply pinnate below, bi- or tripinnate above.

SECTION STAURODORIS.

DORIS VERRUCOSA Cuv.

Bergh **38**, pp. 578—583. Vayssière **2**, pp. 18—23.[1] Cuénot **1**, pp. 10—17.

This form is common in the Mediterranean (Marseilles, Naples, and Trieste) and on the Atlantic coast of France (Arcachon). It attains a length of as much as seven centimetres, but more usually of four or five. The coloration is variously described by the naturalists who have seen the living animal. In most cases the ground colour is yellowish, varying from yellowish-grey to rich orange, but there is also often a bluish tinge, found as a patch in the centre of the back or on the tubercles. The Mediterranean specimens are even described as being of a bluish-violet, but in the Atlantic specimens yellow seems to predominate. The back is studded with both large and small tubercles, of which the larger are generally erect, clavate, and rounded. There are usually three or four tall tubercles round the orifice of each rhinophore, and the branchial pocket bears a circlet of prominences, which often take the form of large and small tubercles set alternately. The branchiæ vary from ten to eighteen in number. Typically they are pinnate, but not infrequently they are bifid or trifid, and more rarely divided into several branches.

D. verrucosa shows considerable variation in (*a*) colour, (*b*) the number and division of the branchiæ, (*c*) the arrangement and shape of the tubercles. In some specimens the tubercles are connected by rudimentary ridges. The radula also shows great variation in breadth, ranging from 45.0.45 to 100.0.100. Vayssière states that two brownish spots in the buccal cavity represent traces of jaws.

D. verrucosa is recorded as occurring sporadically in the British marine area. Mr. G. P. Farran found one specimen at Fahy Bar, Ballynakill, West Ireland (Ann. Rep. Fish. Ireland, 1902—3, part ii, app. vii, 1905, pp. 207—208). Bergh (System der Nudibranchiaten Gasteropoden) unites it with *Staurodoris januarii*, *St. ocelligera*, and *St. pseudoverrucosa*,[2] and including these varieties the species is now recorded from the Mediterranean and Adriatic, the coast of Brazil, the Atlantic coast of Europe, and South Carolina. I have not myself seen the living animal in British waters, but I have examined three specimens described as coming from the Firth of Clyde and Salcombe.

Two specimens from the former locality were courteously placed at my disposal by the Museum of the Manchester University. The larger is 35 mm. long and 21 mm. broad; the other slightly smaller. The details given below refer to the larger specimen, unless otherwise stated.

Both specimens are depressed, rather stiff and hard, uniform whitish-yellow in colour. The back is studded with large and small tubercles. There are fifteen of the former, about 3 mm. high and 2 mm. broad. Smaller ones are scattered among them, and the

[1] Vayssière appears to have in some cases transposed the names *Staurodoris verrucosa* and *Archidoris tuberculata*, *v.* Cuénot *l. c.*, pp. 15–16.

[2] Gadziekiewicz's *Staurodoris bobretzkii*, from Sebastopol; Fischer's *Doris eubalia*, *D. seposita*, and *D. biscayensis*, all from Arcachon, are probably young varieties of *D. verrucosa*.

tubercles decrease in size towards the edge of the mantle, which is fairly wide. The foot is broad; no groove or notch is visible on the anterior margin. The tentacles are ridge-like.

The rhinophore pockets are protected by four tubercles (two large and two small) in the smaller specimen and by three in the other, one of the smaller tubercles not being developed. The branchiæ are simply pinnate, eighteen in the larger specimen, fourteen in the smaller. The pocket has a thin slightly raised lip, bearing eight tall, slender tubercles about 3·5 mm. high, alternating fairly regularly with quite small ones.

The intestines are yellowish, except the stomach, which is black from the colour of its contents. The spermatotheca is very large. The formula of the yellowish radula is 55 × about 60.0.60. The teeth are simply hamate, and rather crowded. The outermost are degraded, but not denticulate. In the anterior, but not in the posterior rows, the innermost teeth project somewhat into the rhachis, which bears longitudinal folds.

DORIS VERRUCOSA Cuv., var. MOLLIS.

One specimen, labelled "Salcombe, R. A. Todd, 3, VIII, 1900." The measurements are: length, 21 mm.; breadth, 12 mm.; height, 7 mm. The colour is white, with a faint yellowish tinge; the texture soft. The foot is 17 mm. long and 6 mm. broad, with a longish free tail; it has slight traces of a groove in front, but no notch. The mantle edge is ample, and measures about 4 mm. The tentacles consist of a ridge-like prominence on either side of the mouth; they are attached for the greater part of their length, and show slight traces of a fold. The back is somewhat sparsely tuberculate. Down the centre run six fairly regular longitudinal lines of large tubercles, about 1·5 mm. wide and 1 mm. high. Between them and on the mantle edge are smaller tubercles. A few tubercles near the branchiæ are taller and almost clavate. There is no trace of ridges connecting the various tubercles. The rhinophores are deeply perfoliate, and emerge between two tubercles. The rim of the branchial pocket is slightly raised, and bears ten tubercles of various sizes, but all quite distinct. The largest are 1 mm. high. The branchiæ are simply pinnate, the pinnæ being alternately long and short. They project about 4·5 mm. from the pocket, and lie flat on the back like a star. Seen thus they appear to be thirteen, but on opening the pocket it is found that nine are long and separate, and four small, springing from the sides of the longer ones. All the plumes are united at the base in a common circular band, which bears papillæ outside. The anal papilla is central.

The intestines are white. In the central nervous system the cerebropleural ganglia are above the pedal, which as preserved lie below them at the side. The eyes are black and distinct.

The bucal mass is elongate. The radula is colourless, with a maximum formula of 40 × 45.0.45. The teeth are rather straight and only slightly hamate. Towards the end of the rows the spike becomes reduced and the base increases, with the result that the tooth resembles a broad, clumsy hook. The two innermost teeth project into the rhachis, and are lower than the rest, but not denticulate.

The œsophagus is thin, and the salivary glands are band-like. The stomach lies in an upper anterior cleft of the liver, but is separate from it. Its walls are thickish, with a strong irregular lamination. The genitalia seem to be as in the typical form. The light-grey hermaphrodite gland is spread over the greenish liver. The spermatotheca is large and spherical; the spermatocyst much smaller and elliptical. No armature was found.

I have compared this animal with specimens of *St. verrucosa* from the Mediterranean. It is lighter in colour, very much softer in consistency, and the tubercles are lower, and, as a rule, not clavate. But these are all matters of degree, and I do not think that a new species can be created on the evidence of a single specimen.

The present specimen is superficially unlike *D. maculata* Garstang, which is very convex, hard, and bears a pattern of knobs connected by ridges.

DORIS MACULATA Garstang.

(Plate VIII, figs. 6 and 7.)

Garstang, Journ. Mar. Biol. Assoc., vol. iv, 1896, p. 167. Eliot **2**, pp. 241—243.

This species is distinguished from all others known in the British area by having the dorsal surface covered with a raised and conspicuously coloured pattern formed of tubercles and ridges. In the specimens which I have seen alive and from which the figures in Plate VIII are taken, the coloration seems to have been paler than normal; the ground tint was greyish-yellow and the tubercles and ridges were purplish. But in the specimens obtained on various occasions by Prof. Garstang the colours were bright yellow and deep purple.

Large specimens are 40 mm. or 45 mm. long and about 20 mm. broad. The body, though rather stiffer to the touch, is flexible and varies in shape; in the same animal the dorsal surface is sometimes strongly arched and sometimes comparatively level. The mantle-margin descends to the ground all round and completely covers the foot when at rest, but when in motion the foot projects behind.

The dorsal tubercles are large knobs, sometimes rising into a peak, but not clavate or constricted at the bases. They are connected in almost all possible directions by ridges of varying elevation and distinctness, and the fields thus formed are traversed by lower irregular ridges some of which show signs of developing incipient tubercles. The arrangement of the main ridges and tubercles is not consistent or regular, but there are usually two or three distinct rows in the middle of the back, two others less distinct nearer to the mantle edge, and on the mantle edge itself numerous smaller tubercles crowded together and not connected by ridges. Between the rhinophores are often two or three large tubercles, and the edge of each pocket, though hardly raised at all, is protected by two tubercles, one on the inner and one on the outer side. The rhinophores themselves are large, yellowish, and closely perfoliate. Prof. Garstang describes the branchial pocket as set with small purplish tubercles, and the branchiæ as five and simply pinnate. In the specimens I have seen the tubercles are not numerous (eight to ten), but of considerable size and capable of completely closing the pocket by meeting

across it. The gills are in all cases five, stout and either bi- or tripinnate. In no case have I seen simply pinnate plumes as described by Mr. Garstang, though there is no reason to doubt their occurrence.

On either side of the mouth is a flattish tentacle, varying somewhat in shape but not recorded as long in any specimen. The anterior margin of the foot is grooved and in some specimens at any rate the upper lip is slightly notched. The foot is nearly as broad as the body and the lateral margins are expanded.

The internal anatomy appears to be much the same as in *D. verrucosa*. In two specimens dissected I found the radula to consist of thirty-seven and forty rows respectively, each containing seventy-five to eighty teeth on either side of the rhachis as a maximum. The teeth are simply hamate with rather blunt tips and no trace of serrulation. Those at the inner and outer ends of the half rows are smaller than the others, and the two or three outermost are irregular and imperfectly formed. On the labial cuticle are two small patches of white rods not combined into a plate; not bifid; straight or slightly curved. These patches are not equally distinct in all specimens and may be sometimes altogether absent. The salivary glands are large and reddish-yellow. The stomach lies wholly outside the hepatic mass and its interior is strongly laminated. The blood-gland is white and consists of two divisions of which the posterior is larger. The central nervous system is as in Bergh's plates of *Staurodoris ocelligera* (Bergh **46**). The genitalia are as in *D. verrucosa*.

This species is distinguished from *D. verrucosa* (1) by the presence of distinct ridges connecting the dorsal tubercles; (2) by the character of the branchiæ, which in all the specimens I have seen (six) are bi- or tripinnate and five only, whereas in *D. verrucosa* they are usually ten or more and simply pinnate. Prof. Garstang, however, found them to be simply pinnate in his specimens. It is therefore possible that *D. verrucosa* and *D. maculata* represent extreme modifications of one very variable form, and are connected by a complete series of intermediate links. One of these links is perhaps the *Staurodoris pseudoverrucosa* of von Jhering from Naples, which has conical dorsal tubercles connected by ridges and five bipinnate branchiæ but no tubercles on the branchial pocket. In general appearance it is said to resemble *D. verrucosa*, which is against its identification with *D. maculata*. Cuénot (*l. c.*) does not notice that in any of the varieties of *D. verrucosa* found at Arcachon dorsal ridges are present.

SECTION ARCHIDORIS.

DORIS TESTUDINARIA A. & H.

(Plate I, figs. 5—8.)

? = *Doris testudinaria* Risso, Hist. Nat. de l'Eur. Mérid., iv, 1826, p. 33.
Doris testudinaria Alder & Hancock **2**, p. 261; and Alder **1**, p. 85.
Archidoris testudinaria (A. & H.) Eliot **1**, pp. 339—344.
Archidoris stellifera H. von Jhering. Vayssière **3**, p. 82; and *id.* in Journ. de Conchyl., vol. lii, no. 2, 1904, p. 123.

Hancock made several drawings of this species, of which two (Pl. VII, figs. 6 and 8) are here reproduced. The others, including the dorsal view of the whole animal, are extremely rough. They are all labelled "*Doris testudinaria, Herm.*" Among the notes (which are not very legible) are the following: "Tubercles small, somewhat irregular, pale with minute pale lines radiating from them. Colour of mantle an obscure chestnut with indistinct pale yellowish blotches at the sides."

Figs. 5 and 7 were drawn from living specimens taken at Plymouth in the summer of 1908.

Both the nomenclature and the specific limits of this form present many difficulties, and it is with great diffidence that I submit it should be called *Doris testudinaria*, that it is identical with the *Archidoris stellifera* of Vayssière and von Jhering, and that it is probably distinct from the *Doris planata* of Alder and Hancock. Two points, however, seem certain: first, that the specimens from Plymouth here described are the *Doris testudinaria* of Alder and Hancock; second, that they are distinct from *Archidoris tuberculata*, with which they are often confounded in practice.

In 1862 Alder and Hancock described (*l. c.*) a new British Dorid, which they identified with the *D. testudinaria* of Risso. From some unpublished notes preserved in the Hancock Museum at Newcastle-on-Tyne, it is probable that they based this identification, not on Risso's description, but on specimens sent from the Mediterranean and labelled *D. testudinaria*, which they considered identical with their specimen from Herm Island.[1] Risso's description is vague, inadequate, and, as pointed out first by Philippi (Enum. Moll. Sicil., vol. ii, p. 78), probably inaccurate. Bergh and others have thought that it refers to *Platydoris argo*. But since Alder and Hancock have given the name to a fully described animal, which is possibly identical with Risso's animal, it would seem that their interpretation of the name must be regarded as authoritative. After Alder and Hancock had assigned the name *D. testudinaria* to an identifiable form, von Jhering gave the name *Archidoris stellifera* to Mediterranean specimens, which seem to me to belong to the same species. His description appears to have been only in MS., and publication dates from the memoirs of Vayssière, who uses the same name. As will be seen from the notes here given, stellate forms are found on the British coast, and are specifically the same as the less ornate variety described by Alder and Hancock. It is remarkable, however, that Vayssière states that the mouth of his specimens is armed with a chitinous ring. I could not discover this structure in a specimen which he kindly sent to me.

Alder and Hancock (*l. c.*) expressed the opinion that *D. testudinaria* and *D. planata* are distinct though similar species. Subsequently Alder in Jeffreys' 'Conchology,' came round to the opposite view, and stated that an examination of further specimens of different sizes from the Clyde proved that *D. planata* is the young of *D. testudinaria*. It is extremely difficult to form any decided opinion on this question. The external characters are likely to vary considerably at different periods of the animal's growth, and it would appear that in *D. testudinaria* (*stellifera*) a labial armature may or may not be developed. Vayssière reports its presence, and Alder and Hancock (*l. c.*)

[1] It is even possible that A. & H. may have obtained the specimens from Risso, or from someone who knew the animal which he called *D. testudinaria*. They were writing about Nudibranchs in 1841, but probably began collecting earlier.

say of *D. testudinaria* and *D. planata*, "the character of the tongue is similar in each." On the other hand, in a number of specimens from Plymouth which I have examined, I have found a decided labial armature in the small flat individuals and none at all in the large plump ones. It is present in the specimen of *D. planata* from Alder and Hancock's collection at Newcastle. On the whole I am inclined to think that there are two separate forms which are very much alike in their younger stages.

(1) *D. planata*. This is a remarkably flat form, which appears not to exceed an inch in length in British waters. The dorsal surface is finely granulated, there is a distinct labial armature, and the radula is decidedly of the type of *Geitodoris* Bergh, that is to say, there are two kinds of teeth, the inner teeth being of the ordinary hamate shape, and the outer very thin and crowded together in sheaves. It is possible that some specimens (about 50 mm. long) which I have received from the Cape Verde Islands may be adults of this species. They resemble the Plymouth specimens, except that they are much larger and were red in life. The richer colour may perhaps be due to the climate.

(2) *D. testudinaria*. This is a plump form of considerable size (60 mm.). The back is covered with flat tubercles, which are sometimes arranged in a stellate pattern. In the specimens from Plymouth, which I have myself examined, there is no labial armature, but Vayssière states that it is present in the Mediterranean form, which is otherwise undistinguishable. The radula is not unlike that of the last species, but the differentiation of the teeth is less marked. The outer are thinner than the inner ones, but the change is less abrupt, and the thinner teeth are not gathered together in such distinct sheaves or packets.

The names *Platydoris testudinaria* and *Platydoris planata* would seem to be in any case incorrect, for none of the animals have the characters of *Platydoris* (which include a peculiar hard consistency and an armature of hooked scales on the reproductive organs). It is possible, but not demonstrable, that the *Doris testudinaria* of Risso was a *Platydoris*; but, if so, it is neither the *D. testudinaria* nor the *D. planata* of Alder and Hancock.

Alder and Hancock's type specimen labelled "*Doris testudinaria* Herm" has been kindly lent to me by the Council of the Hancock Museum, Newcastle.

It is 30 mm. long, 23 mm. broad, and 15 mm. high. The mantle-margin is broken in many places, but it apparently covered the sides and the foot entirely in its original condition. The general colour of the animal is greyish yellow. Some of the dorsal tubercles are lighter than the surrounding surface. There are some reddish spots on the under side of the mantle.

The texture is soft, and the specimen is a little decayed. The back is covered with low flat warts of various sizes. No stellate arrangement is visible. The branchial and rhinophorial pockets are surrounded by tubercles which do not amount to valves. The branchiæ are retracted within the pocket, and their number could not be ascertained. The anterior part of the animal is much retracted, but the long linear tentacles are clearly visible.

The buccal parts have been extracted.

No further examination was made in order not to injure the unique specimen.

I have also examined five specimens seen alive at Plymouth in April, 1905. They vary somewhat in external appearance, and may be described separately.

A. One specimen, rather variable in shape, but flattish. When it is fully extended and in motion its length is 60 mm. and its breadth 32 mm. It is active in its movements. The main colour of the back is mottled purplish brown of various shades, the deepest of which is almost black. The general colour is lighter towards the margin, though here the darker shades are more conspicuous by contrast. There are a few irregular sandy-grey markings here and there, especially in front of the rhinophores, and twelve sandy-yellow star-like figures arranged symmetrically in four lines between the rhinophores and the branchial pocket. The back is covered with flat tubercles, very slightly prominent, and more or less of the same size (not more than 1 mm. in breadth), except those forming the centre of the stars, which are about twice as large as the others. The tubercles forming the stars appear to be set in a stellate figure, but the pattern is due to pigment rather than to the arrangement of the tubercles. The edge of the rhinophore pockets is set with small tubercles. The rhinophores are elongate, with about fifteen perfoliations. They are olive coloured, and the stalk is long compared to the laminated part. The branchial pocket is slightly raised and tuberculate. The branchiæ are six, tripinnate, sandy yellow, with purplish flecks. The anal papilla is purplish, but the edge is crenulate and distinctly margined with sandy yellow. The foot is grooved in front and the upper lamina notched. The tentacles are cylindrical and elongate, which makes the whole head look unlike that of *D. tuberculata*. The under side is white, but in this and in all the specimens there are a few purplish spots on the under side of the mantle, which is rather ample and overhangs the foot all round.

B. In a second specimen of about the same size the characters are exactly the same, but there are only four stellate figures on each side, and they are less regular both in their formation and their arrangement. The pockets of the rhinophores and the branchiæ are very distinctly crenulate and tuberculate.

C. Three similar but rather smaller specimens are paler in colour, and the stellate figures are only imperfectly developed. The branchiæ are as many as seven or eight.

The internal characters of all the specimens are much the same. The blood-gland is large and double, purple or greyish. The central nervous system is not quite as in *D. tuberculata*. Seen from the upper side, the ganglia appear united in a horseshoe-shaped mass in which no divisions are clearly distinguished. Seen from below, the division between the cerebro-pleural and pedal ganglia is plain, but the cerebro-pleural ganglia are not distinctly divided into two portions. The common commissure is thick and very short.

The integuments, especially the tuberculate dorsal surface, are very spiculous, and contain a dense mass of colourless rods, often slightly bent, but not swollen in the middle, jointed, or branched.

No labial armature could be found, but on the labial cuticle in some specimens were granular markings resembling grey dust, but not forming rods or compact plates. The radula consists of about thirty rows, and the number of teeth on each side of the rhachis does not appear to exceed forty-five as a maximum; but the whole radula is fragile and difficult to extend. The teeth are transparent and colourless, longer and thinner than in

D. tuberculata, and with narrower bases. Near the rhachis the teeth are low and with comparatively broad bases; but they increase in length and slenderness towards the outside of the row until the last two or three, which are shorter, but often deformed. Teeth with abnormal lumps and projections occur in all parts of the radula.

The œsophagus is narrow at first, but widens and enters the liver. The stomach lies within the liver. The gall-bladder is small and pear-shaped. The intestine issues from the liver about the middle of its dorsal surface, runs forward and then turns backward. The liver is of a dull orange colour; the hermaphrodite gland, spread over it, is of a dull opaque white.

The spermatotheca is large, greenish or bluish grey, and spherical. The spermatocyst is small, white or orange-white, less distinctly spherical, and sometimes pear-shaped. There is no prostate. The vas deferens is very slender, long, and convoluted; the penis small, conical, and unarmed. The duct seems to issue at the side of the tip.

Though this species is commonly confused with *D. tuberculata*, it seems to differ in the following points:

(1) The typical coloration is different, though it is very often imperfectly developed. But there are nearly always purple spots on the lower side of the mantle, which seem not to occur in *D. tuberculata*.

(2) The general form is flatter.

(3) The shape of the tentacles and anterior part of the foot is markedly different.

(4) The tubercles are less prominent and of more equal size.

(5) The branchiæ are stouter and less voluminous.

(6) The shape of the teeth is different.

(7) The stomach is enclosed within the liver.

For purposes of comparison I have examined a specimen of *Archidoris stellifera*, most kindly sent me from Marseilles by Professor Vayssière. It is 31 mm. long, 16 mm. broad, and 10 mm. high, flattish and rather smooth, with low, even tubercles. The colour of the dorsal surface is dark olive-brown of various shades; the larger tubercles are yellowish, but the stellate appearance is hardly visible. The under side is pinkish, with reddish brown dots on the lower surface of the mantle. The oral tentacles are longish, conical, and somewhat flattened. The anterior margin of the foot is grooved and perhaps notched, but this is difficult to decide. The edge of the rhinophore pockets is set with small inconspicuous tubercles. The branchiæ are eight; the edge of the pocket is tuberculate, much like the rest of the back, but has no special tubercles of its own. The formula of the radula is about 18 × 30.0.30, and the shape of the teeth as described above for the Plymouth specimens.

Neither in this specimen, nor in those from Plymouth, could I find any trace of the armature described by Professor Vayssière (*l. c.*) as "anneau chitineux mandibulaire, complet, assez large, offrant dans la partie interne de petits et très courts bâtonnets prismatiques." Nothing was visible but a thick unarmed cuticle.

I refer this form to *Doris* section *Archidoris*, but if the external teeth are longer and thinner than the internal ones, and if, as Vayssière has found, a labial armature is sometimes present, it is clear that the division between *Archidoris* and *Geitodoris* is not so sharp as might be supposed. It would be interesting to have statistics as to the *uniform* presence

or absence of the labial armature in various species. There certainly seems to be ground for suspecting that in some species of *Doris* it is generally absent, but occasionally present, though not much developed. With reference to this and many other organs, we have little information as to the effect of age and growth on the external and internal characters of Nudibranchs.

GEITODORIS PLANATA A. & H.

Alder **1**, p. 85; Garstang **2**, pp. 445—446.

Alder and Hancock's *Doris planata* has been attributed to the genus *Platydoris* by several authors who in so doing seem to have attended only to the description given opposite the plate and to have neglected the definitions of characters given in the synopsis at the end of the Monograph (pt. vii, p. 42). *D. planata* there comes under the heading:

"** Oral Tentacles linear.

"Lingual spines of two kinds, various: no central spines. Occasionally with a spinal buccal collar."

From this it follows that the animal has a radula with differentiated teeth of two kinds and may have a labial armature. Such an arrangement is not characteristic of *Platydoris*, which is distinguished by a peculiar hard texture and by a special armature on the genitalia, features which have not been found in any British species. At present there is no reason to include *Platydoris* in the British fauna, though it is common in the warmer parts of the Atlantic and Mediterranean.

I have examined the specimen kept in Alder and Hancock's collection at Newcastle labelled "*Doris planata, W. R. Hughes, Sidmouth.*" It is not the specimen from which the description in the Monograph was made, for that animal, we are told, was captured in Lamlash Bay, but it is labelled by Hancock and evidently put in the collection to represent the species, so it must, I think, be regarded as the type specimen. It is only 5 mm. long and 4 mm. broad and entirely dried up, having unfortunately not been kept in alcohol. As far as anything can be made out under such unfavourable conditions, the external characters are much as in Alder and Hancock's plate. The colour is yellowish, the back granulate and pitted, the mantle edge very ample, the branchial pocket large and round. There is a distinct yellow labial armature composed of rods. As usual in these old specimens, the radula is decomposed and in confusion, but there are clearly visible (*a*) ordinary hamate teeth, (*b*) bundles of long, thin, almost shadowy teeth. The whole animal is very flat.

I have examined seven preserved specimens of the form known in the laboratory at Plymouth as *D. planata* but have not seen any alive. They appear to be of the same species as Alder and Hancock's specimen mentioned above, and have the following characters: (1) The dorsal integuments are spiculous and the surface is granulate with tubercles and pits which impart to it as a rule a honeycombed appearance. (2) The anterior margin

of the foot is deeply grooved and the upper lamina notched in the middle. The tentacles are distinct and conical. (3) The rhinophorial and branchial pockets have slightly raised rims, which bear small tubercles but are not lobed. The branchiæ are small and vary from six to nine in number. (4) There is a labial armature consisting of an almost complete ring of short closely packed brown rods. The maximum formula of the radula is about 18 × 10 + 14 . 0 . 14 + 10. The fourteen teeth (or fewer) which are nearer the rhachis are of the ordinary hamate type. The ten outermost are extremely thin and closely crowded. (5) No prostate was found and no armature in the genitalia.

These data appear to me to show that the *Doris planata* of Alder and Hancock is referable to the genus *Geitodoris*. But as already indicated in discussing *D. testudinaria* an uncomfortable doubt hangs about the species, though for purposes of nomenclature I think the evidence of the type specimen is decisive. But in 1869 Alder contradicted the statements made in the Monograph and declared (Alder **1**, p. 85) that "the examination of further specimens of different sizes from the Clyde district proves that *D. planata* of the British Nudibranchiate Mollusca is the young of *D. testudinaria*." Either Alder's statement is incorrect or else the mouth parts of the species vary at different stages of growth, a labial armature being present in young individuals, but disappearing, at least as a rule, in adults.[1]

I do not understand Garstang's description of the radula (*l. c.*). Either he must have chanced on a monstrosity in which the teeth were fused together, as sometimes happens, or he must have been misled by the bundles of thin teeth, which often look as if they were united together.

ALDISA ZETLANDICA A. & H.

(Plate I, figs. 3 and 4.)

Bergh **38**, p. xxxviii; *id.* **16**, pp. 348—352; *id.* **53**, pp. 7—10; *id.* **54**, pp. 5—7; G. O. Sars **1**, p. 305 and plate 27.

From the rough notes at the side of Hancock's drawings it would appear that they were made from two specimens. Of one it is said—"*Doris zetlandica*, Mr. Norman, Shetland. Plumes six, bipinnate, perhaps imperfectly tripinnate. Tubercles of various sizes and shapes. Tentacles (*i. e.* rhinophores) retractile. The margins of the cavities set with four to five tubercles. Colourless or yellowish white." It is not quite plain if this last phrase refers to the whole animal or to the tubercles only. Of the other specimen it is said—"Dredged off Shetland by Mr. Barlee. Tubercles large, distant, soft, papillose: small ones interspersed: linear, obtuse, but probably pointed when alive."

The species seems rare, but is recorded within the limits of the Azores in the south and latitude 66·33° N. I have never had an opportunity of seeing it alive, and as far as I am aware it has not been caught at any of our biological stations. The best and most detailed descriptions are by Bergh (**53** and **54**), from which the following details are extracted. Bergh has also reproduced a sketch of the living animal (**53**).

[1] Vayssière's statement that it is present in the adults of the species which he calls *Archidoris stellifera* must, however, be remembered.

The animal is from 10 mm. to 16 mm. long, rather flat and elongate. The colour is described as greenish grey, but the branchiæ, rhinophores, and tentacles are bright yellow. The integuments are spiculous. The foot has a fine furrow on the anterior margin and sometimes projects behind the mantle. The oral tentacles are short and reduced to small round tubercles. The pockets of the rhinophores and branchiæ are surrounded by small papillæ. The branchiæ are six to eight in number and tripinnate; their pocket is round. The dorsal surface is somewhat sparsely covered with conical pointed tubercles of various sizes. It will be observed that in Hancock's drawing (Pl. I, fig. 3), which is apparently taken from a dead animal, the tubercles are represented as obtuse, but, as he observes in the note quoted above, they were probably pointed in life. In the smaller drawing (Pl. I, fig. 4) they are conical.

There is no labial armature. The radula consists of about fifty rows of teeth with a formula of 100.0.100 or more. The teeth are of a very unusual shape, fairly well indicated in Pl. 46 of Alder and Hancock's Monograph, fig. 2. They are tall, thin, closely packed, somewhat spatulate at the tips, and finely denticulated in about the upper two thirds of their length. The larger teeth have a small hook at the tip. The innermost and outermost are small.

There is a distinct division between the cerebral and pleural ganglia, and the buccal commissure is short. The stomach lies outside the liver. The penis is armed with spines.

This animal is characterized externally by the sparse, conical papillæ on the dorsal surface, and internally by the shape of the teeth, which is unique among known Dorids though it sometimes recalls the dentition of *Sphærodoris*. The affinities of *Aldisa* are very doubtful. It is perhaps allied to the genera *Artachæa* and *Echinodoris*, both from the Indo-Pacific. The latter has long papillæ on the back, an armature of spines on the male genitalia, and denticulate teeth, but differing in shape from those of *Aldisa*.

APORODORIS MILLEGRANA A. & H.

See Monograph, p. 42, and Appendix (2), p. 1.

Von Jhering, Zur Kenntn. der Nudibranchien der brazilianischen Küste, in Malacolog. Jahrb., xiii, 1880, pp. 238—239.

Bergh on *Thordisa dubia* in **50**, pp. 178—190.

By the kindness of Mr. Edgar Smith I have been allowed to see the original specimens of this form (apparently the same as were examined by Alder and Hancock) now preserved in the British Museum. They are labelled "Torquay, Mus. Leach, Mrs. Griffiths," and considering their age are well preserved externally.

The larger of the two specimens is 28 mm. long, 18 mm. broad, and 8 mm. high. The mantle-margin, which is rather thick and solid, is 5 mm. in breadth. The dimensions of the other specimen are rather smaller. The colour (including the branchiæ and rhinophores) is a nearly uniform dull yellow. On the upper surface are two or three purplish spots, clearer in one specimen than in the other and appearing as if below the surface. On the under side of one specimen only are a few brownish spots. The dorsal surface is

closely covered with small spiculous tubercles with whitish tips. This white appearance is due to spicules which project. These spicules, with which the dorsal integuments as well as the tubercles are crammed, are long and often granulated. The pockets of the rhinophores and branchiæ have only slightly raised margins, which are not more tuberculate than the rest of the back. The branchiæ are tripinnate.

One specimen was dissected, but the internal organs were found to be soft and considerably decayed.

There is no labial armature. The radula has a formula of $30 \times 5 + 60.0.60 + 5$ in the broadest rows. The teeth, except the last five, are hamate. The first six or so are low and small. Then they gradually increase in size, and the last fifteen or so of the hamate teeth are very large. All of these teeth bear from two to six minute denticles on the outer side, the number of denticles increasing as the teeth are further from the rhachis. The denticles are hard to see and are only visible when a side view of the tooth can be obtained. This is no doubt the reason why Alder and Hancock do not mention them. They are probably present on all the teeth, but I was only occasionally able to see them in the middle of the half rows. The last five teeth in each row are small, flat, transparent plates with denticulate edges. The denticles are sometimes mere jags, but are sometimes prolonged into long hair-like filaments.

The œsophagus enters the hinder part of the stomach, which is not enclosed in the liver. The intestine issues from the left anterior part of the stomach and after crossing the œsophagus turns backwards. In the much decayed genitalia a large spermatotheca was found and also what seemed to be a prostate, but no armature of any kind.

I think this form is identical with the *Thordisa dubia* of Bergh (*l. c.*) from Rio Janeiro. The range of distribution is wide, but *Doris verrucosa* also has been recorded from the British coast, S. Carolina, Rio Janeiro, and S. Africa. Still, as there is no other record of the occurrence of this species in British waters, it is possible that it may have been a casual visitor, brought on the bottom of a ship.

As a specific name *millegrana* (1856) has clearly priority over *dubia* (1894). It is more difficult to say to what genus the animal should be assigned, and the decision depends on which features in the existing genera are considered the most important. Bergh refers it to *Thordisa* with a query, but the typical *Thordisa* has a back covered with soft villous papillæ. Von Jhering created for Alder and Hancock's *D. millegrana* and for specimens from the Mediterranean which he identified with it, the genus *Aporodoris*, and this genus may be provisionally allowed to stand, for a division is wanted to include those forms which have minute spiculous tubercles on the dorsal surface. Whether the pectinate shape of the external teeth is an essential part of the generic diagnosis may be doubted. But if this character is rejected, a thorough revision of the genera of the *Doridida* might not improbably result in *Aporodoris* being included in some older genus.[1]

[1] E. g. *Atagema*. The dorsal ridge of this genus is not an important character.

ADALARIA LOVÉNI A. & H.

(Plate I, figs. 1 and 2.)

See Alder and Hancock **2**, p. 262. Bergh **18**, pp. 234—237.

This species was described by Alder and Hancock (*l. c.*) as *Doris lovéni*. Loven distinguished two varieties of *Doris muricata* as α and β respectively. Alder and Hancock justly observe that these two varieties are distinct species: in fact, according to Bergh's classification they belong to different genera. Variety β appears to be the original *Doris muricata* of O. F. Müller, 1829, and is a *Lamellidoris*. Variety α was renamed *Doris lovéni* by Alder and Hancock and is an *Adalaria*.

Hancock's sketch of the animal here reproduced is not accompanied by any note as to the locality where it was taken, but it is presumably the single specimen from Bantry Bay noticed in the article referred to above. Bergh has since published a fuller description based on fifteen examples from Bergen.

The species is described by Alder and Hancock[1] as yellowish white and attains a length of 15 mm. It can be easily recognized by the huge tubercles with which the dorsal surface is somewhat sparsely studded. They are soft but have an axis of spicules, which is seen externally as a spot on the tip. Between them are a few smaller tubercles. The rhinophore cavities are protected by two large tubercles. The branchiæ are simply pinnate, eight to ten in number and set in an incomplete circle. The space where this circle is interrupted behind is filled by a large tubercle. This tubercle and some of the others are constricted at the base so as to be almost stalked.

The other external characters and the anatomy are as usual in the genus. The labial cuticle is somewhat thickened and prominent in the inferior median line. The *ingluvies buccalis* is relatively large and set on a short stalk. The radula consists of from forty-two to forty-six rows of teeth with a maximum formula of 12 + 1 . 1 . 1 + 12. The central tooth is a flat plate; the first lateral is large, hamate and smooth; the remaining teeth are flat plates with the anterior edge jagged or denticulate.

LAMELLIDORIS (?) ULIDIANA A. & H.

(Plate II, figs. 6 and 7.)

The only notes on the drawings are "*Doris ulidiana*, taken with oysters from Down or Antrim. Mr. Thompson, see Appendix No. I." This refers to the appendix to the Monograph, pp. ii and iii, where the animal is described and distinguished from *L. diaphana*, to which it is said to come very near. The differences noted are slight and hardly of specific value, but the drawings of the two animals are not strikingly alike, and, as Alder and Hancock after due comparison deliberately recognized *L. ulidiana* as a distinct species, the figures are here reproduced.

[1] Bergh had not seen the living animal.

As the buccal parts are unknown, the reference of the animal to *Lamellidoris* is merely a conjecture, but it is very probable.

LAMELLIDORIS LUTEOCINCTA M. Sars.

(Plate II, figs. 8 and 9.)

See M. Sars, Om Christiania fjordens Fauna, in Nyt Mag. for Naturvidenskaberne, 1870, pp. 189—191; and Farran **1**, p. 4, under *Doris beaumonti*.

Mr. Farran (*l. c.*) describes the living animal as follows:

"Four specimens of a brilliantly coloured little *Doris*, which has already been met with by Mr. Beaumont at Port Erin and Valencia (*loc. cit.* p. 848), were taken at Ballynakill among dead shells in Coastguard deep in six to eight fathoms. The first was found in April, 1900, and was submitted to Mr. Beaumont, who stated it to be identical with his specimens. As it appears to be still undescribed, I suggest the name *D. Beaumonti* for it. The following is a description as far as it has been possible to make it out:

"Length 4·5 mm. Back very high with edges of mantle elevated, slightly upturned in preserved specimens. Tail thick, extending far beyond the mantle, with well-marked keel. Head without tentacles, and not forming a distinct veil, but swollen on either side of the mouth. Rhinophores with six or seven lamellæ. Branchial plumes Mr. Beaumont states he believes to be retractile, but I have been unable to convince myself that this is the case. It is difficult, however, on account of the very small size of the animal to come to a satisfactory conclusion. They seem to be five or perhaps seven in number, and simply pinnate, the anterior three being larger than the rest. Back covered with rather distant, long, soft-looking tubercles, each supported by two or three central spicules which do not project. Extending to the edge of the cloak at intervals are long radial spicules, recalling somewhat in arrangement the ribs of an umbrella.

"The ground colour is glistering white, intensified on the branchiæ and rhinophores and on the median line of the tail. On the back, but not reaching to the margin, is a regular network of reddish crimson, through the meshes of which the white tubercles project. In young specimens the crimson pigment is present in the form of scattered patches between the tubercles. Round the margin of the mantle at a little distance from the edge is a narrow band of lemon yellow. Radula of the type found in *Lamellidoris* and *Goniodoris*, with two large median denticles and two small lateral plates."

I have not seen this animal alive, but have examined two preserved specimens from Millport. They are 5 mm. and 3·5 mm. long respectively. The colour is translucent yellow with traces of a border. The general appearance is as described by Mr. Farran. The back bears sparse, soft, conical tubercles. The integuments contain small spicula, and longer spicula are arranged radially round the mantle-margin. The foot is narrow. No oral veil could be distinguished, but there is a distinct lump on either side of the mouth. The rhinophores are invisible and it would seem completely retracted. The branchiæ, though small and difficult to see on account of their transparency, seem to be as usual in

Lamellidoris, that is to say, non-retractile and simply pinnate. They are not numerous. I could see only four distinctly, but there may be double that number in all.

The radula consists of thirty-four rows, each with a formula of 1 + 1 . 0 . 1 + 1. There is no median tooth, but there appears to be in places a fold on the rhachis. The first lateral is large and stout, with about six denticles rather more distinct than in Mr. Farran's plate. The outer tooth is a small plate which bears a distinct and well-formed hook.

This species was described by Mr. Farran under a new name as *Doris beaumonti*, but there can be little doubt that it is the *Doris luteocincta* of M. Sars, and, so far as its structure can be determined, it appears to belong to the genus *Lamellidoris*. Its coloration is distinctive, but still it is possible that it may be immature.

CRIMORA PAPILLATA A. & H.

(Plate II, figs. 1—5.)

See Alder and Hancock **2**, p. 263; and Alder **1**, p. 74.

This species has been taken twice in Moulin Huet Bay, Guernsey, on zostera in shallow water, but to the best of my knowledge has not been seen since 1865. In external appearance it is not unlike *Euplocamus*, though the papillæ are smaller, more numerous, and less branched. The buccal parts are unlike those of all known Polycerids.

The body is plump and limaciform, rising towards the branchiæ and descending towards the tail. The oral veil is bilobed, and bears on either side five processes, some simple and some branched. This veil is continued laterally as a not very prominent pallial ridge, bearing numerous small papillæ, the last of which on either side is bifid. Similar papillæ are scattered over the sides of the body where they are arranged in two irregular rows, over the dorsal surface, and over the tail, where (to judge from the drawing) they are united and form a sort of ridge. The oral tentacles are short and tubercular. The rhinophores are perfoliate and retractile within short sheaths. The gills are three in number and tripinnate. The colour is white, but the rhinophores, branchiæ, and the tips of all the processes are light yellow.

Alder and Hancock's specimens are unfortunately not forthcoming, but a preparation of the radula[1] has been preserved. It consists of about forty rows. There is no central tooth. The first lateral (which is often hidden by the second and was apparently not seen by Alder and Hancock) is rather small and bears only a rudimentary hook. The second is of the large falcate type found in *Plocamopherus*, *Polycera*, etc., with a spur on the base which projects into the rhachis over the first lateral. The third to the seventh teeth are less distinctly hamate, but rise up into a more or less pointed projection which becomes longer and longer, until the eleventh, which is almost flagelliform but smooth. The remaining teeth are very long, slender, and minutely denticulate. They lie in a sheaf or bundle, so that it is difficult to count them, but there must be at least twenty to thirty.

The printed descriptions do not state whether there is any labial armature or not.

[1] The teeth in Fig. 5 are drawn from this preparation.

But I have found a rough drawing of the radula by Hancock on which he has written "No jaws, no collar in second spec. examined in 1865." No generic or specific name is written on the paper, but the radula is unmistakable, and the specimen mentioned is no doubt the one which Alder (*l. c.*) says was found by Mr. Norman in 1865. It may therefore I think be concluded that the labial cuticle is not provided with jaws or other armature, and that *Crimora* is probably allied to *Triopa*, which has the same peculiarity. The use of the long external teeth is not known. Something similar may be seen in the radulæ of the Rhipidoglossa and of *Rostanga pulchra* and *R. muscula* among Dorids. There is no information as to the genitalia of *Crimora*.

PLEUROPHYLLIDIA LOVÉNI Bergh.

(Plate VIII, figs. 8—10.)

Bergh **4**, p. 29; *id.* **15**, pp. 77—86. Alder **1**, pp. 17—18.

This species is not uncommon on the British coasts. I have examined several specimens from both Plymouth and Lowestoft. The living animals are from 30 mm. to 40 mm. long. The dorsal surface is of a rather bright brick red, marked with a varying number (twenty to fifty) of longitudinal white lines, some of which are broader and plainer than the others. The rhinophores and the edge of the tentacular shield are whitish; the rest of the shield is reddish. The branchiæ and side lamellæ are yellowish. The foot is white with a reddish tinge. The branchiæ are thin and about twenty; the side lamellæ very thick and about thirty. In front of the rhinophores is a low broad prominence (the caruncle). When the animal is alive this prominence is not easy to see, but it is not small and bears several indentations on its upper surface.

The jaws bear from five to seven rows of denticles. The radula consists of from twenty-five to thirty-five rows with a formula of from 30.1.30 to 35.1.35. The median tooth is fairly broad and bears about seven denticles on either side of the central cusp. The first lateral is rather lower and broader than the others. The teeth in the inner third or so of the row (the first eleven in one specimen, the first thirteen in another) are denticulate and bear a varying number of denticulations which does not exceed seven and sinks to two or three after the sixth tooth. In the rest of the row (after the eleventh tooth or so) the teeth are smooth.

It would appear that the *Pleurophyllidia* found on the British coast is this species and not *Pl. undulata* (*lineata*) as it is sometimes called. It differs from *Pl. undulata* in its colour, in having fewer and thicker side lamellæ, and in its dentition. In *Pl. undulata* the central tooth is much broader, and all the teeth, with the exception of the last two or three in each row, are denticulate.

DENDRONOTUS LACTEUS Thompson.

See *Tritonia lactea* Thompson in Ann. Nat. Hist., vol. v, p. 88.

This form is dismissed as a variety of *D. arborescens* both in the Monograph and by Alder (**1**, p. 63), but E. Becker (Mollusk. von Jan Mayen, 1886, p. 14) maintains that it is a distinct species, characterized not only by its milk-white colour but by differences in the frontal appendages and the radula. He says that it bears on the frontal veil four appendages in the upper line and two smaller below, in the middle. The median tooth of the radula is smooth, not denticulate as in *D. arborescens*, and the formula is 6 or 7 + 1 + 6 or 7, whereas in *D. arborescens* it is 9 or 10 + 1 + 9 or 10. These lateral teeth have short hooks and bear three denticles.

I have not had an opportunity of seeing this form.

LOMANOTUS Vérany, 1844.

Alder and Hancock, Monograph, Fam. 3, genus 10 (under name of *Eumenis*). Garstang **1**, pp. 185—189. Beaumont **1**, pp. 842—844. Colgan in Ann. and Mag. Nat. Hist., 1908, vol. ii, pp. 205—218.

The members of this genus are not common, and large specimens are rare, though small ones are not infrequent in some localities, *e. g.* Plymouth. The body appears to be very delicate and easily torn, and most authors report that their specimens were badly preserved. The following species have been described:

1. *Lomanotus genei* Vérany, Catal. degli. anim. invert. di Genova e Nizza, 1846.
2. *L. hancocki* Norman, Ann. Mag. N. H., vol. xx, 1877, p. 518.
3. *L. portlandicus* Thomps., Ann. Mag. N. H., vol. v, 1860, p. 50.
4. *L. eisigii* Trinch., Rendic. Acc. Sci. Fis. Mat., xxii, 3, 1883, pp. 92—94.
5. *L. flavidus* A. & H., Monograph, Fam. 3, pl. 41.
6. *L. marmoratus* A. & H., Monograph, Fam. 3, pl. 1.
7. *L. varians* Garstang, *l. c.*

Of these names the last is proposed by Garstang for all the British species (*L. marmoratus*, *L. flavidus*, *L. portlandicus*, and *L. hancocki*), on the supposition that they are really one. But if that supposition is correct, the right course would seem to be not to introduce a new name, but to call all the forms by the earliest of the existing specific names. *L. varians* may therefore be omitted from the list. The remaining six forms may be divided into the large and the small. Of the large forms *L. genei* has undoubted priority as a name, and it is unfortunate that the authors of the remaining three large species, *L. hancocki*, *L. portlandicus*, and *L. eisigii*, did not, in describing them, state definitely in what points they considered them to differ from the typical species. It seems certain that the number of processes on the frontal veil and on the rhinophore sheaths differs in otherwise similar individuals and cannot be made a specific character. *L. portlandicus* is not distinguished from *L. genei* (*l. c.*) by any clear character. Norman

states that the most marked character of his *L. hancocki* is "the small size of the terminal, simple, conical process, which is projected beyond the calyx-like sheath" of the rhinophores. But it is highly probable that the rhinophores were of the usual type, and that the lower laminated portion was merely hidden within the sheath. Trinchese (*l. c.*) has given a somewhat detailed description of *L. eisigii*, from which it appears that its most remarkable characters are: (1) that the hepatic diverticula do not extend into the marginal papillæ; and (2) that the two margins unite at the end of the body and form "una larga pinna che è l' organo principale del nuoto." But a similar organ is found in the specimen described below, and is figured in some unpublished drawings of *L. portlandicus* made by Hancock, and preserved in the Newcastle Museum. Alder and Hancock, as well as Bergh, found the hepatic diverticula in the papillæ, but I could not demonstrate their existence with certainty in the specimen which I examined. It is possible that different specimens may vary in this respect, as do *Dendronotus* and *Bornella excepta*. Trinchese also states that in the *young L. eisigii*, "Ogni papilla conteneva un lobo epatico bene sviluppato."

While the present work was going through the press, I received a copy of a paper,[1] in which Mr. Farran expresses the opinion that there are two large species of *Lomanotus* found in British waters, namely, *L. genei* and *L. portlandicus*, characterized as follows. The colour of *L. genei*, though variable, is always deep and, it would seem, usually crimson, flecked with white spots. The maximum formula of the radula is 32 × 36.0.36. The verge is long (about 10 mm.) and uniformly tapering. In *L. portlandicus* "the general coloration of the body is transparent white, suffused with pale orange red. The papillar fringe is basally of an orange red colour, the tips of the papillæ being opaque white. The only variation in colour to which this form is subject tends to a suppression of the orange red coloration, which is occasionally entirely absent." The radula attains a maximum of 42 × 58.0.58, although the animal is rather smaller than *L. genei*, and the verge is short and thickish (about 6 mm. by 1 mm.).

Mr. Farran admits that the "differences in colour would not be sufficient to maintain the soundness of Thompson's species," and the specific validity of the other characters is questionable, for the radula in *Lomanotus* is peculiarly difficult to count, and in all Nudibranchs the shape and size of the verge vary according to the retracted or exserted condition of the organ. But my own investigations do not support Mr. Farran's theory that these characters are always grouped together in the way he describes. After reading his paper I dissected a specimen captured at Plymouth in 1908 which in life was white, suffused with orange red, and which still shows that the base of the papillar fringe was reddish and the tips of the papillæ white. In coloration, therefore, it is *L. portlandicus*. But the formula for the radula does not exceed 32.1.32[2] and the verge is thin and slightly tapering. It is 8 mm. long and only ·5 mm. broad at the base, so that it is almost thread-like. Thus in these two characters the animal is *L. genei*. While not wishing to

[1] Farran **2**.

[2] In *Lomanotus* the teeth in the middle part of the radula are rather widely spaced, but if a given vertical space be taken as representing the rhachis the number of teeth on the two sides of it is often not the same. I am inclined to believe that there is a rhachidian tooth, but that in most cases it has ceased to be strictly central in position.

dogmatize about the specific distinctions of rare animals, of which no adequate figures have been published,[1] I do not think we have any proof that there is more than one large species of *Lomanotus*, somewhat variable in the size of the radula and in coloration. The whole range of colour variation seems to me less than is known to exist in many Chromodorids, and Mr. Farran admits that the white forms, which superficially look different from the others, are merely varieties. In a specimen from Ballynakill which he has kindly sent me as representing in his opinion the true *L. genei* I can find no white spots, though it is possible they may have been present in the living animal. The *facies* of this specimen is exactly that of Hancock's largest figure (pl. III, fig. 1), called by him *L. portlandicus*, except that the reddish-brown colour is deeper and more uniform.

The small species are *L. marmoratus* and *L. flavidus*, both British. With regard to these the main question is, have they assumed their adult and final form, or are they immature? Trinchese states that the young of *L. eisigii* differs markedly from the adult; and if we recognize the possibility of modifications occurring during growth, it may be said that the two small species present no characters either externally or in the buccal parts which are incompatible with the idea that they are the young of *L. genei*. On the other hand, if they are mature (on which point the evidence is inconclusive), the differences in size and colour are, no doubt, sufficient specific characters. A further question is whether *L. marmoratus* and *L. flavidus* are distinct forms. If they are adults, they must certainly be regarded as separate species. But if they are immature, then considering that *L. flavidus* is smaller than *L. marmoratus*, and that Trinchese states that the young *L. eisigii* is æolidiform, it is probable that *L. flavidus* is the youngest stage of the same species. Alder and Hancock note the æolidiform characters of the type specimen. I have examined at Plymouth a small living individual 4 mm. long and 1 mm. broad which resembled their plate in coloration and external appearance. In the buccal parts and general structure it agreed with *L. marmoratus*, except that the short thick papillæ, which were only twelve in number, showed no sign of a bulb.

As mentioned below, Alder and Hancock's published plates of *L. marmoratus* are wrong in representing the dorsal margin as continuous with the oral veil.

I recognize provisionally three species:

1. *L. genei* Vérany.
   = *L. portlandicus* Thomps.
   L. hancocki Norman.
   L. eisigii Trinchese.
2. *L. marmoratus* A. & H.
3. *L. flavidus* A. & H.

It is possible that both of these latter will prove to be young forms of the first, but I

[1] I have not seen a coloured drawing of the Mediterranean form, which must be the true *L. genei*, if more than one species is recognized. Professor Vayssière kindly informs me that he has seen an unpublished coloured sketch by Vérany representing the colour of the animal as "teinte laque avec points blancs," but adds that dead but fresh specimens examined by himself were "rouge-bruns." Vérany published a black and white figure (Catalogo degli Animali invertebrati, 1846, pl. ii, fig. 6) in which the white spots are distinct and circular.

have seen living specimens of *L. marmoratus* 13 mm. long, which bore little resemblance to *L. genei*.

LOMANOTUS GENEI Vérany.

(Plate III, figs. 1—8.)

Bergh **11**, vi, pp. 5—8, and **12**. Vayssière, Moll. Opisth. de Marseille, part iii, 87—91. Gamble, Ann. Mag. Nat. Hist., ser. 6, vol. ix, 1892, p. 379.

Hancock made twelve drawings of this species (described as "*Lomanotus portlandicus*, Mr. Wm. Thompson, December 15, 1855") from which figs. 1—6 of Plate III are selected. Figs. 7 and 8 were drawn from a living specimen caught at Plymouth in 1907.

I have dissected one large specimen from Plymouth Sound, kindly given to me by Mr. W. I. Beaumont.

The colour of the preserved specimen is yellowish white suffused with brown, which is deepest on the pericardium, rhinophores, oral veil, mantle-margin with papillæ, and on the tail. There are no white dots. Some, but not all, of the papillæ have colourless transparent tips.

The length is 26 mm., the breadth at most 8 mm., and the height 9 mm., including the raised margin. This margin starts from the rhinophore sheaths and is 2—3 mm. wide. It bears thirty-two papillæ on the right, and thirty on the left side, and is bent into six undulations, three upwards and three downwards. The largest papillæ are those in the centre of these undulations and are about 4 mm. high; the rest are about half the size. The papillæ are distinctly spoon-shaped, the convex surface being generally outside, but sometimes inside. At the base of the larger papillæ are two folds on the inside. The margin is entire round the tail and forms a horizontal fin. The anus is 15 mm. from the anterior end, and the genital orifices are 6 mm., just behind the rhinophores. The oral veil bears four distinct digitations, two on each side, about 2 mm. long. The rhinophore sheaths are about 3 mm. high; the right bears five digitations; the left, though apparently uninjured, has only one. The sheaths are slit in front, and the margin is reflexed at the sides and behind. The foot is produced into short pointed angles and is grooved. The upper lamina is much stronger and thicker than the lower.

The jaws are yellow, rather soft and flexible, and much as described by Bergh. The margins for some distance inwards are covered by a mosaic of plates or scales with denticulate edges. The masticatory process is very short.

The radula corresponds in general with the descriptions of Bergh and Vayssière. It consists of thirty-two rows. The teeth are large, crowded, and yellow at the sides of the rows; smaller, spaced, and colourless in the centre. In this specimen, and in all the smaller ones examined, the radula has a great tendency to break and become confused, and it seems impossible to spread it out evenly. It is hard to say whether there is a central tooth or not, as the arrangement appears to be not quite symmetrical. Down the rhachis run four or five irregular and not quite straight rows of very irregularly shaped teeth (Fig. 7 a), bearing a central cusp and three to seven pointed denticles of various sizes on either side. To the right and left of these teeth the rows become more regular, and then

come about ten colourless dagger-like teeth (Fig. 7 b), with from four to ten fairly regular denticles on either side, the number of denticles increasing as the teeth are further from the rhachis. After this the teeth, as one goes outwards, become larger, yellower, hollowed, and somewhat spoon-shaped, bearing on either side at least twenty-five denticles, which are shorter and blunter than those of the middle teeth. The outermost teeth of all are somewhat smaller.

The internal organs are not easy to unravel, all the tissues being very thin, soft, and easily torn. The œsophagus leads into a round stomach, which gives off branches, apparently one on either side, and is prolonged posteriorly in a diverticulum reaching nearly to the end of the body. On this lie the liver and the hermaphrodite gland, both of which are yellowish and difficult to separate from one another. The whole mass is surrounded by a network of transparent tubes, which seem to represent the kidney. The dorsal papillæ are hollow and communicate with the interior of the body, but I could not satisfactorily demonstrate the existence of branches of the liver in them (*cf.* what Trinchese says about *L. eisigii*). If such exist, they are represented by flocculent masses of no very definite shape, composed of reddish cells. In the unusually pale and transparent specimen represented in Figs. 7 and 8 they are seen to extend into the lower parts of the large papillæ and rhinophore sheaths but not into the tips. The mucus and albumen glands are large; the ampulla of the hermaphrodite gland is long and thick; the vas deferens thinner and coiled; the penis conical and unarmed; the spermatotheca small and roundish.

If any valid distinction can be drawn between *L. genei* and *L. eisigii*, this animal should probably be referred to the latter in virtue of the shape of the papillæ and the apparent absence of hepatic diverticula in them. But I do not think that the two species are really distinct.

LOMANOTUS MARMORATUS A. & H.

Four living specimens (A) examined at Plymouth in April, 1905, were about 9 mm. long and 2 mm. broad. The ground colour of the living animals is yellowish white, but largely covered with irregular markings of different shades of brown and olive, and also with small sandy dots. The colour is darkest at the sides and lighter in the centre of the back. The tips of the cerata are whitish; the hepatic diverticula within them yellowish brown.

The anterior margin of the foot is cleft and indented, with strongly hooked corners. The veil is not large, with four processes, two on each side, which are somewhat bulbous at the tip. The rhinophore sheaths are rather tall for the size of the animal, being about 2 mm. high, and bear four or five processes, the number not being always the same on the right and left sheaths. In one specimen one sheath is entirely smooth. The dorsal margin starts from the rhinophore sheath; it makes four not very distinct undulations and bears about twenty-two papillæ, most of which, especially the taller ones, are carried vertically, though some of the smaller ones point sidewards. The taller papillæ bear a distinct bulb under the pointed tip, but in the smaller ones the bulb is less developed. Four of the

papillæ are distinctly larger than the rest, and, roughly speaking, mark the divisions between the undulations. The third of these larger papillæ is the tallest of all and is about 2 mm. high.

Another specimen (B), which was about 7 mm. long when at rest and 8 mm. when crawling, was brownish white, with yellowish-brown mottlings down the centre of the back and deep purplish-brown mottlings on the cerata. The other external characters are much as in the specimens already described, but the papillæ are not so long and there are only obscure indications of the subterminal bulb. The dorsal margin is more clearly a web connecting the papillæ. The rhinophore sheaths bear five processes each.

Three other specimens of about the same size were so macerated that nothing could be done with them except to examine the buccal parts.

The jaws and radula are much the same in all eight specimens. The jaws are not denticulate, but near the edge is a mosaic formed of tile-like prominences with denticles on their anterior margin. The radula is very irregular in appearance and could not be laid out straight in any specimen. There is a wide naked rhachis bearing folds, and on each side of the rhachis are fifteen to twenty rows of teeth, each containing eight to ten teeth on either side. More could not be made out with certainty. The teeth are longer than in Alder and Hancock's and Bergh's plates, and more uniform. They are dagger-shaped, but slightly bent at the end, bearing at least twelve denticles on either side and perhaps considerably more, but the denticles are hard to see, even with a high power. The innermost are slightly shorter and stouter; the outermost longer and thinner.

The animals are very delicate. They die in captivity without apparent cause, and the body becomes decayed and macerated very rapidly.

This form, especially the specimen called B, approaches the *L. marmoratus* of Alder and Hancock sufficiently near to bear the name. Their plate (*Eumenis marmorata*, Fam. 3, pl. 1, A) contains one of the few inaccuracies to be found in their works, inasmuch as it represents the dorsal margin as continuous with the oral veil, not as starting from the rhinophores. But in a preliminary study for the figure preserved in a bound volume of Alder's drawings, belonging to the Hancock Museum at Newcastle-on-Tyne, the disposition of the parts is somewhat indistinct, and it is probable that it was intended to represent the dorsal margin as starting from the rhinophores. When this study was copied for the plate as published, the artists themselves may have misinterpreted their earlier and rather indistinct drawing.

Colgan (*l. c.*) not only regards *L. marmoratus* as synonymous with *L. genei*, but wishes to give the former name priority on the ground that Vérany used the binominal Latin name first in 1846, and in 1844 simply said it was a species of *Lomanotus* "dedicata al Prof. Gené." But the identity of the two forms is not sufficiently certain to warrant the use of one name for both, and, apart from that, if the rules are to be applied with such severity to Vérany, it might be objected that Alder and Hancock's figure represents a differently formed animal and that *L. marmoratus* must have that conformation. I do not however think that we should insist that the continuity of the dorsal margin and oral veil is really a character of *L. marmoratus* A. and H.

HANCOCKIA Gosse.

= *Govia* Trinchese.

Bergh (**44**, p. 1048) adopts *Govia* (Trinchese, 1886) as the name of this genus in preference to *Hancockia* (Gosse, 1877), apparently on the ground that Gosse's description is inadequate. But though Gosse does not deal with the anatomy of the animal, his description is amply sufficient for its identification. There can be no reasonable doubt that his *Hancockia eudactylota* is the animal described below, and that it is generically and perhaps specifically the same as the later *Govia* of Trinchese. The name is therefore entitled to stand.

The genus appears to be rare, and is recorded from the south of England, Brest, and the Mediterranean. Four described species are probably referable to it: *Hancockia eudactylota* Gosse; *Govia rubra* Trinchese; *Govia viridis* Trinchese; and *Doto uncinata* Hesse. In the Journ. de Conchyl., 1872, p. 34, Hesse described under this name a Nudibranch captured at Brest, but Garstang seems to have proved that it is a *Hancockia*. Whether there is really more than one species is a matter of some doubt. Perhaps Trinchese's two species are distinct, and perhaps his *Govia viridis* is identical with both *Doto uncinata* and *Hancockia eudactylota*, so that the genus may be tabulated as follows:

1. *Hancockia eudactylota* Gosse, S. England.
2. *H. uncinata* Hesse, Brest.
3. *H. viridis* Trinchese, Mediterranean.
4. *H. rubra* Trinchese, Mediterranean.

Hesse regarded his specimen as a *Doto*, and Bergh somewhat doubtfully refers the genus to the *Dotonidæ*. It would seem to be intermediate between that family and *Lomanotus*, but nearer to the latter. The narrow radula indicates affinity to *Doto* and the true Æolids. The cerata show analogies to those of *Doto*, though they have not their characteristic shape. But the perfoliations on the rhinophores, the processes on the oral veil, and the manner in which the cerata arise from the dorsal margin recall the characters of *Lomanotus* rather than of *Doto*.

HANCOCKIA EUDACTYLOTA Gosse.

Gosse, On *Hancockia eudactylota*, Ann. Mag. Nat. Hist., ser. 4, xx, 1877, pp. 316—319; Gamble, On Two rare British Nudibranchs, *Lomanotus genei* and *Hancockia eudactylota*, *ib.*, 6, ix, 1892, pp. 378—385; Trinchese, Richerche anatom. sul genere Govia, Mem. della R. accad. delle sci. dell' istituto di Bologna, ser. 5, vii, pp. 183—191, 1886; Bergh **44**, p. 1048, 1892, *sub voce* Govia, Eliot **1**, pp. 354—356 and figures.

Two specimens labelled "Plymouth district, Sept. '97 and '98." They are of much the same size, one being rather more elongate than the other. Measurements in millimetres:

	Length.	Breadth.	Height.
(1)	7	1·2	2
(2)	6	1·5	2

The colour is greyish green, and the shape rather stiff and rectangular. The animals are not very well preserved either externally or internally; but a small specimen subsequently given me by Mr. Allen proved to be in better condition and was sectioned.

The foot is truncate in front; no groove is visible on the anterior margin; the tail is not pointed behind, and is slightly bifid.

The oral veil is smooth in the middle and curves inwards, but the two sides are much expanded and each bears four digits, of which the second from the inside is the longest. The rhinophore sheaths, which are set on the dorsal margin, are about 1 mm. high and 5 mm. broad, straight, cylindrical, not expanded at the top, but divided into eight to ten low lobes. The upper part of the rhinophores is a smooth column; at the base are a few obliquely vertical perfoliations. From the rhinophore sheaths runs backwards a not very distinct marginal ridge, on which are set five processes on the left side and four on the right. The processes in the first pair are opposite one another. Then they gradually become alternate. They bear lobes with a rather irregular outline, so that the whole process looks like a short, thick branchial plume. The first pair have eight lobes, four on each side, and are folded along the median line, the concave surface being turned outwards. The second, third, and fourth pairs are similarly folded, but bear only seven lobes, three on each side and one terminal. The fifth process (found on the left side only) has five lobes and is irregular in shape. The genital orifices are close to one another, on the flank of the body, between the rhinophores and the first process. The vent is between the first and second processes, close to the dorsal margin.

The nervous system is yellowish. The ganglia are hard to separate, but as seen from above appear to be as described by Trinchese. The cerebro-pleural ganglia are large and triangular, showing no sign of division. The pedal ganglia, which are smaller, lie at their side on a lower level. The buccal ganglia are large. The eyes are large and of an intense bluish black.

The jaws bear a row of distinct but irregularly shaped denticles on the masticatory process. Higher up on the jaw itself there seem to be numerous projections near the edge. The radula resembles that of *Galvina*, and consists of thirty-one rows of three teeth each. The median teeth are very strong and distinct, with four well-developed denticles on either side of a large raised median cusp. The laterals are very thin and hard to see, but are much as in *Galvina*, broad, but with a sharply pointed summit.

The animals being small and indifferently preserved, it was difficult to make out the digestive system by ordinary dissection, and the following details are derived almost entirely from the specimen which was sectioned. A fairly long œsophagus leads from the buccal mass to the stomach and gives rise about midway to a curved diverticulum. The stomach is roundish and not very large. From the top of it rises the intestine which sends out a tube to the anal papilla on the right. The anterior lower part of the stomach is prolonged into two diverticula which supply the first pair of cerata and then run straight forward, terminating in the anterior part of the foot. The termination is trifid. Posteriorly the stomach gives rise to a long and fairly wide tube which extends to the hinder part of the body and sends off branches to the cerata. These branches are at first simple, but before they enter the cerata they divide into as many ramifications as there are lobes to supply. These secondary ramifications arise at different levels. At their

termination they open externally by orifices which appear to be cnidopores. These consist of a fairly broad tube, which is narrowed by a constriction when it reaches the integuments and forms outside the constriction a cup-shaped aperture. There are traces of similar openings on the anterior margin of the foot; but it is unusual to find cnidocysts in this position, and the structure of the organ is not clear. Abundant mucus glands are scattered over the whole surface of the body, and the mucus can be seen under the microscope in the act of exuding.

The hermaphrodite gland is large and fills all the posterior part of the body-cavity with large yellowish packets. The anterior genital mass is also well developed, but hardened and not well preserved. No trace of armature was found, and the spermatotheca appeared to be surrounded by the albumen gland.

HERO Lovén.

G. O. Sars **1**, p. 316, pl. xxviii. Bergh **32**, pp. 309—314; *id.* **14**, p. 699. Vayssière **1**, pp. 88—92. Eliot **2**, pp. 239—241.

Hero is a somewhat aberrant genus which in its general structure, especially the buccal parts, approaches very near to the Æolididæ but differs from them in having branched cerata, one pair of which is situated on the frontal margin before the rhinophores. The known species are confined to the northern Atlantic and the Mediterranean. Bergh gives four, but of these *H. mediterranea* (Costa) appears to be founded on a misprint. Costa in the Ann. del Mus. Zool. della R. Univ. di Napoli, 1866, p. 41, includes in a list of fauna "*Cœlia* (a synonym of *Hero*) *mediterranea* Nob. Golfo di Napoli." But on p. 90 of the same publication under the heading "Alcune correzioni ed aggiunzioni" we read "pag. 41, verso 12, *Cœlia* leggi *Tenellia*." The species is therefore not a *Hero* at all, but the *Tenellia mediterranea* described by Costa in the same paper, which is perhaps an *Embletonia*. *Hero fimbriata* is the *Doris fimbriata* of Vahl (Müller, Zoologia Danica, 1788, vol. iv, p. 22) described as *Doris flavescens pedicellis dorsi apice fimbriatis* and depicted on pl. cxxxviii, fig. 2, which represents a yellow and pinkish animal with slightly branched processes on the sides of the back and frontal veil. It seems to me to be a *Tritonia* or *Marionia*.

Two valid species are known: *Hero formosa* described below and recorded from the northern Atlantic, and *H. blanchardi* Vayssière from the Mediterranean. The latter is yellowish, with red cerata; the frontal appendages are ramose, but those at the side of the body are small and either undivided or simply bifid.

HERO FORMOSA Lovén.

(Plate IV, figs. 1—4.)

This beautiful animal is not plentiful on the British coasts, but has been recorded from several points such as St. Andrews, the Frith of Clyde, Northumberland, and

Plymouth. Like many other Nudibranchs it has been observed to appear suddenly in a locality and after a time to desert it altogether.

Hancock's fig. 5 was drawn from an animal captured on a Pecten in twelve fathoms of water at Millport. It was active in captivity, but soon died, and was about 12 mm. long.

The living animal is of a transparent white with a more or less decided rosy tinge. Down the centre of the back and on each side of the body runs a line of vivid opaque white (three lines in all), and there are scattered flakes of the same colour on the body and cerata. Large specimens attain a length of nearly 20 mm., but the majority are only half this size. The shape is slender and elegant.

The foot is slightly expanded in front, but neither grooved nor produced into tentacular prolongations. It is fairly broad, with thin expanded lateral margins. The tail is short. The oral tentacles are unusually large, broad, and flat. They are curved backwards, and may equally well be described as an oral veil with produced ends. Immediately above them is the first pair of cerata. Then come the rhinophores, two straight simple pillars, slightly tapering but with no sheaths and no perfoliations. This latter point is established by those who have seen the living animals, but in preserved specimens the rhinophores often appear to be wrinkled and lamellated. Behind the rhinophores come from three to six pairs of cerata. The structure of all of these (including those in front of the rhinophores) is the same, but they differ in size and subdivision, the second or third being the largest and those near the tail quite small. They appear to be formed by a process of bifurcation repeated four or five times in the largest, but as the secondary branches are close to the primary the arrangement often appears to be quadrifid. The genital orifices are on the right hand side under the first of the cerata after the rhinophores; the vent is under the second. The diverticula of the liver pass into the cerata and extend right up to their tips. There are no cnidocysts.

The jaws are large but thin and transparent. The cutting edge bears a line of irregular denticles and sometimes shows traces of two lines. The radula is triseriate and consists of from forty-five to over sixty rows. The teeth are much as in *Galvina*. The central tooth is strong and bears from two to four denticles placed rather irregularly on either side of the median cusp, which is moderately long. The laterals consist of a not very broad basal part from which rises a pointed but not hooked spine. The liver consists of two principal trunks, which enter the stomach right and left and send off diverticula into the cerata.

HERO FORMOSA var. ARBORESCENS.

Eliot **2**, p. 239.

I have examined three specimens from St. Andrews which seem to constitute a variety characterized by the great development and ramification of the cerata compared to the size of the animals, which look like nearly circular pieces of branched seaweed. The larger cerata are divided into four branches, each of which is subdivided four times, and on the tip of each subdivision are four points, which, however, are not completely

developed in all cases. There is no trace of the usual white lines and spots. They may have disappeared owing to the action of the preserving fluid, but they usually remain in preserved specimens.

The central teeth of these specimens had consistently three strong denticles on either side, the first pair nearly as large as the central cusp.

JANOLUS HYALINUS (A. & H.).

= *Antiopa hyalina* A. & H.

(Plate V, figs. 4—7.)

Bergh **47**, pp. 7—11.

The figures of this animal given by Alder and Hancock, plate 44, are not good, but those now published will, it is hoped, be found more satisfactory.

The notes on the drawing merely say "Mr. Byerly: 29 Aug., 1854. Animal active, moves rapidly."

The species has been described by Bergh (*l. c.*) and referred by him to the genus *Janolus*. This genus has most of the external characters of *Antiopella* (= *Janus*, = *Antiopa*), but is distinguished by its huge undenticulate jaws, which form the sides of the buccal mass. Several species have a very broad foot with an expanded margin, but this character is not present in all. *Janolus hyalinus* is also nearly allied to *Proctonotus* (which has somewhat similar jaws), inasmuch as it has cerata studded with knobs, and the two genera are only distinguished by the absence in *Proctonotus* of a crest between the rhinophores.

I have not had an opportunity of seeing *Janolus hyalinus* alive, but have examined two preserved specimens captured at Plymouth, one 8 mm. long, the other only 4·3 mm.

They agree as to external characters with Alder and Hancock's description. The colour is yellowish, with traces of lighter and darker mottlings. The cerata are crowded and irregularly set. There are generally four to five in a transverse row. The innermost are the largest and about 5 mm. high; they decrease in size outwards, and the outermost are mere tubercles. They bear knobs, as described by Alder and Hancock. The anterior margin of the foot is somewhat undulated, with a bend inwards in the middle. It is not grooved in the ordinary way, but the sides of the head are developed into lappets, which extend downwards towards the sides of the foot and form a ridge nearly parallel to them. There is a small fold round the head bearing two distinct tentacles. The rhinophores bear irregular perfoliations which do not go all round the club. The interrhinophorial crest is elongate.

The jaws are large and smooth, with no denticles. The radula consists of fifteen rows varying from 11. 1. 11 to 13. 1. 13. The teeth are hamate and increase in size from the rhachis outwards, the last but one being the largest, and the outermost of all smaller. They bear three to five (rarely seven) long ridge-like denticles, which are not very small, but difficult to see on account of the extreme transparency of the teeth. These denticles

seem to have escaped the notice of both Alder and Hancock (Tongues of the Eolididæ) and of Bergh, who all describe the teeth as smooth. The denticulation is probably variable.

DOTO CUSPIDATA A. & H.

(Plate V, figs. 1—3.)

Alder and Hancock **2**, p. 263. Alder **1**, pp. 61—62.

Alder's account of this species is as follows:

"Body slender, white or yellowish, spotted with pink or purple; head with an arched veil produced into recurved points at the sides; tentacles slender, tapering a little upwards; the sheaths trumpet-shaped with scalloped margins; branchial processes ovate-conical, with four rows of strongly pointed conical tubercles and a terminal one at the apex; the tips are without spots; papillæ six on each side; foot narrow, a little expanded in front. Habitat, in 75—80 f. on the Outer Haaf of the Whalsey Skerries, Shetland. This species, of which a single specimen was obtained during the Shetland dredging expedition in 1861, comes very near to *Doto coronata*, from which it differs in the papillæ having much more pointed tubercles without the terminal spot. The tentacular sheaths also have scalloped margins and the veil is more arched than in *D. coronata*."

The notes on Hancock's drawings say "Shetland, Mr. Jeffreys, 1861," and repeat in a disjointed form the substance of the above description. Of the rhinophore sheaths they say: "margin reflected and produced into several points, the point in front being much larger than the others." The preserved specimen was about 6 mm. long.

It is unfortunate that this species is founded on a single specimen, for nearly all Dotos are known to vary considerably in colour and shape. Still the shape of the cerata as drawn and described seems a valid specific character: it distinguishes *D. cuspidata* from *D. coronata* and *D. fragilis*, and *D. pinnatifida* is clearly a separate species. Nothing is known of the buccal parts and internal anatomy, but the known species of *Doto* do not show much variety in this respect.

As a name *Doto cuspidata* has priority over the numerous species created by Hesse (1873) and Trinchese (1877—9). It is perhaps identical with *D. cornaliæ* Trinchese, which differs from it only in having a pink ring formed of minute spots round the bases of the cerata. Alder and Hancock (**2**) say that *D. cuspidata* is "spotted on the back with pink or purple, the spots forming two lines of curves between the branchiæ," which may be a way of describing imperfect rings. It is possible that Trinchese's *D. costæ* and *D. aurea* are also varieties of this same species, for different as they are in general appearance they have the same characters: conical cerata with prominent pointed tubercles, scalloped rhinophore sheaths, and a coloration consisting of a yellow or white ground with darker mottlings formed by minute spots.

DOTO CINEREA Trinchese.

Trinchese **1**, p. 92, pl. lv. Vayssière **1**, pp. 102—106.

At different times I have seen at Plymouth three living specimens, probably referable to this species, which is recorded from Genoa, Marseilles, and the Cape Verde Islands.

The animals are small, being rarely more than 5—6 mm. in length. The ground colour of both the body and the cerata is buff or dull yellow, but the dorsal surface, especially at the bases of the cerata, is mottled with dark brown or black. The amount of this mottling (and consequently the general colour of the animal) varies greatly in different individuals. The tips of the tubercles which the cerata bear are white, and never dark as in *D. coronata*.

The frontal veil is somewhat ample and projects at the sides. The rhinophores are rather long and the edges of their sheaths are crenulate. The foot is broad. There are from four to six pairs of cerata, rather elongate and studded with small spherical tubercles arranged rather irregularly in from three to five rows. The terminal tubercle is about twice as large as the others. The radula is a row of from eighty to ninety teeth, which have a few (two to three) indistinct and irregular denticles at the sides of the median cusp. The jaws are very thin and delicate and the cutting edge is smooth.

In many respects this species resembles *D. cuspidata*, but is distinguished from it by the shape of the cerata. In *D. cuspidata* (*D. cornaliæ*, etc.) these are said to bear elongate and very prominent tubercles; in *D. cinerea* the tubercles are small and spherical and the cerata have somewhat the appearance of elongated and compact bunches of currants. I think the species is valid, but it is a very inconspicuous little animal. It can easily be distinguished from *D. coronata* by the white tips of its papillæ.

DOTO PINNATIFIDA (Mont.).

This species seems to exist in several varieties, of which I have noticed three at Plymouth.

(1) Var. *splendida* (= *Doto splendida* Trinchese). This is probably the young of the typical form. It varies from white to light drab colour, and is punctuated, especially on the back, with distinct black dots, which are not at all confluent. The ridges in front of the rhinophores are absent and the lateral papillæ are developed only imperfectly. The cerata are elongate and almost cylindrical; the oral veil is narrow.

This form is not infrequent at Plymouth. All the specimens which I have seen were quite small, not exceeding 5 mm. in length.

(2) Var. *nigra*. This variety is produced by the multiplication and coalition of the dark markings found on the typical *D. pinnatifida*. The colour thus becomes deep dark grey or black, either uniform or with lighter mottlings. But the sole of the foot, the anal papilla, and the rhinophores remain of a clear bright yellow, the rhinophores contrasting vividly with their dark sheaths. The ridges on the oral veil are distinct, but the papillæ on the sides of the body are not well developed. The rim of the oral veil is usually yellowish. The margin of the rhinophore sheaths is deeply jagged. The jaws are very

thin and the radula consists of about seventy teeth, bearing a moderately high central cusp and two or three lateral denticles.

I do not think that this is *Doto obscura* described by me from the Cape Verde Islands. It may, however, be a dark variety of *D. aurea* Trinchese, in which the reticulate violet pattern has almost obliterated the yellow background.

(3) Var. *papillifera*. Three specimens from Plymouth, nearly a centimetre long. The coloration, cerata, etc., are typical of the species as described by Alder and Hancock, but there are numerous papillæ on the back, each with a black spot at the tip; and there are two or in some places three rows of such papillæ on the sides. The rhinophore sheaths are ample in front, but slit behind, and bear two or three papillæ. All these papillæ are too long to be called tubercles, and are half or even three quarters of a millimetre in height. The anal papilla is very large.

The buccal mass is very small and the radula minute, though it contains more than one hundred closely fitting teeth. The teeth bear at least three denticles on each side of the central cusp and perhaps other accessory denticles and ridges; but it is difficult to get a distinct view of any tooth, even under the highest power.

This form is probably a variety of *D. pinnatifida* with the tubercles more developed. All the proportions of the animal are larger than those described by Alder and Hancock, and it is possibly merely the normal adult form.

CUMANOTUS Odhner.

Odhner **1**, pp. 29, 80, and 101—102. Eliot **1**, pp. 361—363, and Eliot **3**.

The genus *Cumanotus* was created by Odhner in 1907. The British species referable to it, *C. beaumonti*, had previously been described as an aberrant *Coryphella*, but the establishment of a special genus is quite justified. *Cumanotus* is allied to *Coryphella* inasmuch as it has unperfoliate rhinophores, tentacular angles to the foot, a triseriate radula, and denticulate jaws. But it also possesses the following special characters: (1) the oral tentacles are very small and connected by a cutaneous fold which runs across the head and forms an oral veil; (2) there are several, at least three, rows of cerata in front of the rhinophores; (3) the verge is deeply grooved, and there is a bursa copulatrix, the entrance to which bears on its upper and lower margin a circular pad armed on the periphery with twelve small cones terminating in hooks.

CUMANOTUS BEAUMONTI (Eliot).

= *Coryphella beaumonti* Eliot.

(Plate VIII, figs. 1—5.)

I have not seen the animal alive myself, but Mr. Beaumont, to whom the species is dedicated, has kindly supplied me with the following notes:

"*Eolid from Barn Pool* (*Plymouth*).—Length 16 mm., but looks as if the posterior

part of the body had been lost, as it ends abruptly only 3—4 mm. behind the heart.[1] The outline of the anterior end of the foot is like *Eolis nana*, except that the sides are produced into small angular projections kept tucked in and consequently inconspicuous. Head nearly as wide as the foot. The oral tentacles very minute; merely short processes of angles of the oral veil. The rhinophores are long and smooth, held erect with tips bent back. The eyes do not show. Papillæ very numerous and extremely long, slender and tapering to fine points, constantly in motion, curling and uncurling, and when at rest convoluted. A group of small papillæ, apparently three rows, is wholly in front of the rhinophores on each side. Then a row on each side abreast of rhinophores. Another row between this and the next, which is abreast of the anterior end of the heart. Then a row level with the posterior end of the heart. The outer ends of the rows are not double.

"The colour of the body is red, tending to orange on the rhinophores, but elsewhere more rosy. The colour seems to be situate in the superficial tissues. The papillæ are superficially flesh-coloured. The hepatic cæca are in most of the papillæ rosy purple throughout, but in a few pale greenish purple, except at the tip, which is rosy purple in all and more deeply coloured than the rest of the organ. The cæca are slender, especially at the distal ends, and much corrugated. The extreme tips of the papillæ beyond the end of the cæca are yellowish flesh colour, deeper than the superficial colour of the rest of the papillæ."

I have examined two preserved specimens given me by Mr. Beaumont, 20 mm. and 14 mm. long respectively. The colour is dead white, not very transparent. The hepatic diverticula in the cerata are yellowish white and corrugated. The external characters agree with Mr. Beaumont's description. The front of the foot is broad and expanded, but the tentacular angles are small and bent downwards and inwards. The anterior margin is not grooved. Over the mouth is a broad oral veil (5·3 mm.) expanded into short tentacles (1·7 mm.) at the sides. The rhinophores are long (7·5 mm.), thin, not perfoliate, and placed close together on a slight prominence. There are three rows of cerata distinctly in front of them. The cerata are set on eight narrow, curved ridges, which are single and do not form horseshoes. The first three rows are close together, the next three not far apart, but the last two are more distant. In the perfect specimens the length of the cerata obscures this arrangement. There are four to six cerata in each row. The cerata in front of the rhinophores are short, cylindrical, and 2—4 mm. long. The posterior cerata are very long; in the specimen, which has a body 20 mm. long, they measure as much as 15 mm. and are about 1 mm. broad at the base.

The jaws bear two or three rows of denticles. The radula is triseriate, and consists of twenty and fourteen rows respectively in the two specimens. The central tooth has a strong central cusp, which bends slightly downwards, and hence sometimes appears asymmetrical when pressed flat in a slide. On each side of it are a number of small denticles of varying shape and size. The smallest number observed was sixteen and the largest twenty-four. The laterals are also broad, with slightly lower cusps, and twenty to thirty accessory denticles on the inner side. No denticles were visible on the outer side of the laterals. The female orifice is dilated into a bursa copulatrix. The upper and lower

[1] The specimens here described are much the same.

margins of the entrance are each armed with a circular or elliptical pad, which bears round its margin twelve conical tubercles terminating in hooks. They appear not to be hard or chitinous (fig. 5).

The penis, which is partially protruded in one specimen, is sickle-shaped and very deeply grooved, consisting of a lamina folded down the middle and probably capable of assuming a foliaceous expansion. It is unarmed. The spermatotheca is large and spherical.

With respect to the function of these pads Mr. L. R. Crawshay writes to me from the Plymouth Laboratory, where he watched the movements of *Cumanotus* in the tanks, that what was observed points strongly to the conclusion that they are really ♀ clasping organs. "If the organs of the one individual are called A (♂), B (♀), and of the other, X (♂), Y (♀), what was observed was as follows: The two individuals were placed right to right with the complete apparatus of both extended and approximating. The base of A (♂) was grasped laterally by an upward extension (*i. e.* presumably the pads) on both sides of Y (♀), and the base of X (♂) was similarly grasped by upward lateral extensions of B (♀). In each case a sort of peristaltic movement on the part of B (♀) and Y (♀) occurred. As the grasp of B (♀) and Y (♀) extensions relaxed, the flow of spermatozoa from X (♂) and A (♂) respectively was distinctly visible, while as the grasp of the extensions closed round the base of X (♂) and A (♂), the flow of spermatozoa was checked." As far as I am aware, a female clasping organ of this kind has not yet been recorded among Nudibranchs, but it is possible that in some other genera of Æolids its nature may have been misunderstood.

The spawn consists of a short spiral coiled about six times and suspended by a thread (fig. 4).

It is doubtful whether *Cumanotus beaumonti* and *Cumanotus laticeps* are specifically the same. The identity is not improbable, but Odhner's specimens (judging from the figures) had lost all the cerata. *Cumanotus beaumonti* is remarkable for having a short truncated body and extremely long snaky cerata, but when these have fallen off the Plymouth specimens look very like Odhner's figures, and have the margin of the foot similarly expanded. There may also be differences in the denticulation of the jaws and lateral teeth. But these are slight divergences, and hardly of specific value unless associated with others. Still, until a complete specimen of the Norwegian form has been examined it is safer not to unite the two species, and provisionally I think the genus may be tabulated as follows:

Cumanotus Odhner, 1907.

1. *C. beaumonti* (Eliot), 1906.
2. *C. laticeps* Odhner, 1907.

If the species are united the name *beaumonti* has priority.

C. laticeps is known by four specimens obtained at Sörvær, in the extreme north of Norway, in 5—10 fathoms of water. *C. beaumonti* has been captured at Plymouth, twice in Barn Pool, and on several occasions in Jennycliffe Bay, at a depth of 2—5 fathoms, and though far from common, appears to be a resident and not merely a visitor.

CORYPHELLA SALMONACEA (Couth).

Bergh **3**, pp. 89—99; *id.* **24**, pp. 7—8; *id.* **54**, pp. 33—34.

This species is not recorded by Alder and Hancock from British waters, but Mr. Chas. L. Walton (who has kindly supplied me with the following description) reports that the boats of the Lowestoft Marine Laboratory found it in great abundance about lat. 55°50′ N., long. 0°35′ E., at a depth of 30—45 fathoms. It seems to be characterized externally by having large oral tentacles and numerous small crowded cerata, which extend to the tip of the tail, but leave a bare median space for three quarters of the length of the back. But I have not been able to obtain a drawing of the living animal.

Measurements of a large specimen: length 20 mm.; height 5 mm.; breadth 5 mm.; length of tentacles 5 mm., of rhinophores 4 mm., of cerata 3·5 mm. Body firm, foot narrow, tapering to a somewhat obtuse point at tail, and produced at the angles into thin points. Oral tentacles broad and thick, rhinophores slightly wrinkled. Eyes small; behind rhinophores. Cerata numerous and irregular in size. The grouping is obscure, and they continue almost to the tip of the tail. A bare space extends from the head for about three quarters the length of the back. The body is semi-pellucid white, as are also the tentacles and rhinophores; they often bear a line of opaque white down the front. The cerata are reddish brown or fawn-coloured, with a distinct white ring just below the tip. The dorsal surface is tinged with reddish brown, and bears a faint white line along the tail. The jaws are strong and of a dark horn-colour. The radula consists of sixteen to eighteen rows of pale yellowish-white teeth. The central tooth is broad with a strong median cusp and seven to eight denticles on either side. The lateral teeth are slender and acute, with eight to nine small irregular denticles. The number of denticles seems to vary considerably, and is reported by Bergh as being in some specimens as many as nine on the central teeth and twenty-six on the laterals.

EMBLETONIA PALLIDA A. & H.

(Plate VI, figs. 1 and 2.)

= *Embletonia grayii* Kent, in Proc. Zool. Soc., 1869, pp. 109—111; probably also = *Embletonia fuscata* Gould and *Embletonia remigata* Gould.

Alder **1**, p. 36. Bergh **13**, pp. 36—39. Meyer and Möbius **1**, pp. 17—18.

Alder's description of the animal is as follows: "Body yellowish white, with a few black spots on the back. Tentacles (rhinophores) approximating; head lobes indistinct, forming a semicircular veil which is a little produced at the sides; branchial processes nearly linear, set in a double longitudinal row of four or five on each side of the back. Length 0·1 mm." The number of cerata, position of the rhinophores, and shape of the oral veil, as well as the colour, seem to make this a valid species distinct from *E. pulchra* and from the dubious *E. minuta*. But Kent's *E. grayii*, which differs from it chiefly in having three cerata in some groups instead of two, is probably merely a variety.

Bergh has given an account of the anatomy based on specimens from Massachusetts, which he regards as undoubtedly referable to this species. They were 2 mm. long as preserved and had not more than two cerata in any group. The jaws are finely denticulate. The radula consists of about forty teeth in a single series. They are of the usual horse-shoe shape, and bear about seven denticles on either side of the not very prominent central cusp. Cnidocysts are present though not found by A. and H. in *Embletonia pulchra*.

AMPHORINA Quatrefages.

Eliot **1**, pp. 363—368.

In the paper referred to above I have discussed the relationships of *Amphorina* and of the genera comprising Bergh's family Cratenidæ, and shown how small are the differences which separate them, and how often species fail to present all the characters of the genera to which they are referred.

Of the genera *Cuthona*, *Cratena*, and *Amphorina*, the last may be retained provisionally, for it will be a convenient division if many Æolids are discovered having the characters of *Amphorina sensu stricto* (*e. g.* like *A. cærulea*). But I can see no sufficient reason for separating *Cuthona* and *Cratena*; for the only certain characteristic which distinguishes them is that in *Cuthona* the head is broad, in *Cratena* narrow. The assertion made by Bergh that in *Cuthona* the auditory capsule contains a single otolith, but in *Cratena* several otoconia, has been disputed. If only one genus is recognized it would seem that the name *Cavolina* used by Alder must be rejected from nudibranch nomenclature and that *Cuthona* has priority over *Cratena*. Alder (**1**, p. 43) referred to *Cuthona* (1) *C. nana*, (2) *C. peachii*, (3) *C. stipata*, (4) *C. angulata*, (5) *C. inornata*, (6) *C. concinna*, (7) *C. olivacea*, (8) *C. aurantiaca*, (9) *C. pustulata*. Of these (4) is almost certainly a species of *Æolidiella*, (5) remains somewhat doubtful, (7) and (8) are here referred to *Amphorina*. The remaining species are retained as *Cuthona*, and to them are added a few more called *Cavolina* by Alder and *Cratena* by Bergh.

Though I retain *Amphorina* provisionally, I doubt if it will prove to be more than a section of *Cuthona*. In the typical forms it has a long tapering radula and a penial stylet, whereas *Cuthona* has a short radula and no armature on the genitalia. But these characters are not constant in all forms, for *Cuthona amœna* is said to possess a penial stylet, and *Cratena fructuosa* and *Cr. gymnota* (which are Cuthonas according to the nomenclature here adopted) have long tapering radulas.

AMPHORINA CŒRULEA Montagu.

(Plate VI, figs. 6—8.)

= *Eolidia bassi* Vérany.

Alder **1**, pp. 51—52. Bergh **2**, pp. 57—61; *id.* **13**, pp. 37—39. Vayssière **2**, pp. 60—65. Trinchese **1**, pl. xxx, xxxii, xxxiii; *id.* I primi momenti dell'evoluzione nei molluschi, in R. Accad. dei Lincei, 1879—1880, p. 3; *id.* Protovo e globuli polari dell' *Amphorina cœrulea*.

A slender, elegant animal, which may attain a length of 15 mm., but is generally much smaller. The details of its gorgeous coloration are somewhat differently described by different authors, and probably vary according to the light and position in which the animal is seen. The body varies from greenish yellow to orange and this same tint is maintained in the oral tentacles and rhinophores, but the cerata are marked with bands of blue and brilliant yellow or orange red and have pale tips. Respecting the colour of the animal Mr. Beaumont observes (Beaumont **1**, pp. 837—838): "The description of the papillæ in this species given by Alder and Hancock (*loc. cit.*) is wanting in the accuracy usual with those authors. They say, 'Central gland . . . green below and dark blue above; outer surface of the papilla above pale blue, below pale green; a few yellow freckles in front; tips strongly capped with orange red, banded below with a ring of bright yellow; extreme points colourless and pellucid.' In point of fact the hepatic cæcum is dark bottle-green throughout, the brilliant metallic blue colour of the middle part of a papilla being entirely due to reflection from small flecks of opaque superficial material. Above and below the blue there is usually a band (often incomplete posteriorly) of yellow or orange, also superficial; and near the tip of the papilla the cnidogenous sac shows through yellow, orange, or sometimes crimson. The general colour of the sheath is pale, transparent green. The extent of the blue and yellow or orange colour is subject to much variation in different individuals, and in the different papillæ of the same individual; often some of the opaque material appears white by reflected light, especially when the background of dark green afforded by the hepatic cæcum is lacking. Prof. Herdman's description of the papillæ of *Æ. molios* is somewhat vague; there appears in his account of the species very little reason, as I think, to separate it from *A. cœrulea*."

The foot is fairly broad, and the corners are produced into small prolongations. The oral tentacles are short, but the rhinophores very long, smooth, and straight. The cerata are cylindrical, moderately long, and set in five to nine groups. The first group is the largest and contains seven to ten cerata; the others decrease progressively towards the tail and contain only five, four, three, or two.

The jaws bear a single line of denticles. The long radula[1] consists of a single series of sixty to eighty teeth. They are of the horse-shoe shape and rather broad; the lower part of each side limb is expanded. They bear a central cusp, and on either side five to seven (usually six) denticles. The central cusp, though long, rises far back and points upwards more than usual, so that its proportions are not clearly visible. The radula tapers in a remarkable manner, the hinder teeth being at least twice as broad as those in front. This phenomenon seems due to the persistence of the older and smaller teeth, which do not drop off as quickly as in other genera.

The penis is armed with a long, straight, chitinous tube.

[1] In their Synopsis (Pt. vii, p. 51) Alder and Hancock class *Eolis cœrulea* under the heading *Lingual plate with large denticles and a stout central spine. Two separate plain lateral plates.* But it is clear that in this and several other instances the position accorded to a species in the synopsis cannot be accepted as evidence of the character of the radula, unless there is proof that Alder and Hancock examined the radula. In the present case they had not seen a specimen of *E. cœrulea* when they wrote the Monograph (see Appendix, p. xi), and the position given it must represent a mere guess.

Vayssière has described the spawn, which is short and shaped like a crescent, with the two horns turning inward, and Trinchese has given some particulars of the early development of the ova.

CUTHONA (?) NORTHUMBRICA A. & H.

(Plate VI, figs. 4 and 5.)

There remain of this species four figures by Hancock, one of which is similar to the drawing of the whole animal in the Monograph but not so good; one is a rough drawing of a rhinophore, and two are reproduced here. With the figures are notes to the effect that two specimens were captured on Cullercoats Rocks on April 11th, 1861. There follows a description of the living animal which is practically identical with that in the Monograph, except that the papillæ are said to be set in ten or eleven rows, with five papillæ in the larger rows. Hancock adds: "The figure in the plate (*i. e.* plate 31, fam. 3 of the Monograph) is pretty correct. There can be *no* doubt about the species. . . . The original description is very correct." It would appear that fig. 4 in Plate VI of the present series was drawn from a living specimen but fig. 5 from a dead one.

No further specimens of the animal have been found since the time of Alder and Hancock, and as the anatomy is unknown the genus remains uncertain.

CUTHONA (?) INORNATA A. & H.

(Plate VI, fig. 3.)

Alder **1**, pp. 46—47.

The drawing is by Alder. The animal is briefly described in the Appendix to the Monograph, p. ix (25), where it is suggested that it may be a variety of *Æolidia papillosa*. But the stout cylindrical papillæ hardly support this suggestion, and the classification in the Synopsis (pt. vii, p. 50) which places it with *E. olivacea* and *E. aurantiaca* is more probable. The animal has not been seen since the time of Alder and Hancock, and without further examination it is impossible to say to what genus it is referable.

ÆOLIDIELLA ANGULATA (A. & H.).

? = Æ. glauca var.

See Eliot **1**, pp. 357—358.

Mr. C. W. Walton informs me that he considers a specimen which he captured near Plymouth to be undoubtedly the same species as that figured in the Monograph under the name of *Eolis angulata*, and has kindly supplied me with the following notes on the appearance of the living animal and on the radula:

"One specimen, obtained by the otter trawl of the Oithona, 2¼ miles S. by W. of Rame Head, June 11th, 1909, in about 30 fathoms. Length 16 mm. Breadth behind rhinophores 7 mm. Length of oral tentacles 6 mm., of rhinophores 4·5 mm. Rhinophores fairly stout, wrinkled. Eyes prominent, situated at the base of the rhinophores, on their outer side. Foot broad, angles rather short, stout and acute. Body stout, smooth and tapering gradually to a rather obtuse tail. Heart prominent. Papillæ fairly numerous, of moderate length, stout, tips obtuse; set in twelve rows, the first two of which are double, and run forward almost to the base of the oral tentacles; nine to ten papillæ in each anterior row. The four anterior rows strongly erected on irritation.

"*Colours.*—Foot, head and oral tentacles semi-pellucid white; dorsal area and about the base of the papillæ yellowish. Rhinophores tinged with orange, the tips faintly freckled with opaque white; the tips of the oral tentacles are similarly marked. A number of faint orange lines tinge the rhinophores, and form an orange area in front of them. Papillæ light brown, freckled with opaque white, the tips semi-pellucid white, the dots becoming confluent and forming an irregular band in that area. The jaws large, horny and dark brown in colour. The radula contained twenty-one plates; each plate bears some thirty slender teeth on either side, the central cusp not very pronounced, and flanked by two widely diverging, acute, lateral denticles.

"It will thus be seen that the radula differs from those of both *Æolidiella glauca* and *Æ. alderi* in detail, although agreeing with both in general character."

The arrangement in the synopsis (Part vii, pp. 48 and 50) implies that the animal has not a radula like *Eolis glauca*, but as pointed out above under *Amphorina cærulea*, Alder and Hancock in making this synopsis rashly classified several species as if they had examined the radula, when they had not done so.

I had previously come to the conclusion (*l. c.*) after examining a specimen which Prof. W. Herdman regarded as *Eolis angulata*, that the species was identical with *Æolidiella glauca*, but the opinion of Alder and Hancock, now supported by Mr. Walton, that the two species are distinct cannot be neglected. The animal described by Mr. Walton is clearly an *Æolidiella*, and it differs from *Ælla. glauca* (1) in colour; (2) in the broad foot with projecting angles; (3) in the cerata, which do not show the same curious vermicular shape and movements; (4) in the shape of the teeth, in which the central cusp is flanked by two denticles pointing outwards. I confess that I am not convinced that these characters are really of specific value, for specimens of *Æolidiella* apparently referable to the same species show great variation both in external characters and in the denticulation of the teeth. But pending the examination of further specimens, *Ælla. angulata* merits provisionally separate recognition. It is possibly the species from Heligoland described by Heinke (**1**, p. 247) as *Æolidiella* nov. spec.? While thinking that this form may merit recognition as much as *Ælla. alderi*, I am inclined to agree with Cuénot[1] that all the so-called European species, *glauca*, *alderi*, *angulata* and *sömmeringii*, are really varieties of one, which ought to bear the first of the above names.

[1] Faune d'Arcachon, Eolidiens, p. 3.

CALMA A. & H.

Much confusion has arisen about this genus, for later authors have not paid sufficient attention to the statements made about it by Alder and Hancock, and these statements, which are scattered in various parts of the Monograph, are not always plain if taken separately, though if taken all together they are clear enough. Alder and Hancock described the type species first in the letterpress to plate 22 (under the name of *Eolis glaucoides*) as a very curious *Eolis* which will probably constitute a new generic type, and pointed out the remarkable characters of the "gastro-hepatic vessel" and "the ovary." Their language about the radula in this passage is wanting in precision, but in the letterpress to plate 47 (Tongues of the Eolididæ) they say that the tongue is very slender, resembles a continuous band, and can only be seen in profile. The figure clearly represents the tongue as I have found it, a continuous chitinous ribbon in which the teeth are fused together and only appear as minute serrulations. On page 21 of the Appendix they create the genus *Calma* for *Eolis glaucoides*, but unfortunately mention only the external characters and do not refer to the anatomy.

Hence Trinchese, followed by Bergh (**8**, pp. 643—647, and **12**, pp. 61—64) and Vayssière (**1**, pp. 84—88), regarded the genus as akin to *Flabellina*, and referred to it the *Eolis cavolini* of Vérany.

Later (Rend. Accad. Sci. Fis. Mat. di Napoli, xx, 5, 1881, pp. 121—122, and Mem. Ac. Sci. Istit. di Bologna, S. iv, T. x, pp. 57—61) Trinchese described under the name of *Forestia mirabilis* a Mediterranean Æolid having all the main characters of Alder and Hancock's *Calma glaucoides*—the thread-like undivided radula, the broad, simple hepatic system, and the hermaphrodite gland arranged along the two sides of the body. Friele and Hansen had also (**1**, 1875, pp. 78—79) described another species from the northern Atlantic, calling it merely *Eolis albicans*, but indicating its affinities to the genus *Calma* A. & H. Bergh (**44**, pp. 1025 and 1034) puts *Eolis albicans* under *Forestia*, and makes the genus *Calma* consist of *C. glaucoides* A. & H. and *C. cavolini* (Vérany).

There can, however, be little doubt that the genus *Calma* is equivalent to the later (1881) *Forestia*. It will then contain three species.

1. *C. glaucoides* A. & H. Atlantic.
2. *C. albicans* Friele and Hans. Atlantic.
3. *C. mirabilis* (Trinchese). Mediterranean.

C. albicans appears closely allied to *C. glaucoides*. *C. mirabilis* differs in having a few separate teeth, as well as the continuous chitinous band, and it would seem that the groups of papillæ do not rise from a common stalk.

It seems probable that *Calma cavolini* does not belong to this genus. It is regarded by Bergh and Vayssière as related to *Flabellina*, from which it differs in having no perfoliations on the rhinophores. The radula is not like that of *Calma glaucoides*, but has separate teeth of the usual pattern. There is some doubt whether it is triseriate or uniseriate, the laterals being in any case very small. It would seem that in some points the digestive and reproductive organs resemble those of *C. glaucoides*, but neither Bergh nor Vayssière suggest that it resembles *Forestia mirabilis*. They had perhaps not seen

Trinchese's paper at the time they wrote. Whatever may be the true affinities of the form, the differences in the buccal parts prevent its being referred to *Calma*, and I would propose that it should be rebaptized *Calmella*.

Though the anatomy of *Calma* is characterized by a certain simplicity, this simplicity is no doubt not primitive, but secondarily acquired and connected with the unusual diet of the animal, which feeds on the eggs of fish. The nature of the food explains the degeneration of the radula and perhaps also the absence of cnidocysts (see Grosvenor, "On the Nematocysts of Æolids," Proc. Roy. Soc., 1903, vol. lxxii, no. 486, p. 469). Several of my specimens seemed to be gorged and distended with gelatinous matter, and probably the creatures' habit of thus stuffing themselves accounts for the breadth and simplicity of the alimentary passages.

CALMA GLAUCOIDES A. & H.

Seven specimens received from the Plymouth Laboratory. Two of them resemble Alder and Hancock's figures more than do the others, which are flatter and have swollen, almost ovate cerata. But no differences of structure were found, and as all the specimens were identified at the Laboratory with *C. glaucoides*, it is probable that they were all alike externally when alive.

The length varies from 10 mm. to 4 mm. and the breadth from 4 mm. to 2 mm. The general colour is whitish or drab, but varies in detail, because the transparent integuments allow the contents both of the body and of the cerata to be seen. The broad digestive tract with its diverticula is generally coloured a pale dull yellow, but contains here and there blackish masses in the cerata as well as in the main alimentary tract. In two specimens these black portions are so large that the general colour appears to be bluish black. At the sides of the body between the cerata the white follicles of the hermaphrodite gland are distinctly visible. The integuments are generally brownish at the sides of the body and at the bases of the cerata.

The margin of the foot is expanded both in front and at the sides, so as to be considerably wider than the head and body; anteriorly the foot is rounded, and is produced on either side into a short tentacular process, which is almost invisible in many specimens. The cerata are set in from nine to twelve rows, the most common number being ten. Each row contains two or three cerata, more rarely four. The stalk or common base on which they are set is not at all conspicuous, but when an attempt is made to detach them they come off in twos or threes, and not separately. They are not at all caducous. In most specimens they are oblong-ovate in shape; but in two (as in Alder and Hancock's figures) they are cylindrical. The tentacles and rhinophores are both small, without a trace of perfoliations.

The jaws are thin, smooth, and colourless. The radula consists of a colourless, continuous band, bent into a roughly semicircular shape, and bearing sixty to one hundred denticulations like the teeth of a saw, and gradually increasing in size. Below the row of denticulations (*a*) there can be seen under a high power three or four series of minute pits and projections (*b*). No trace of any loose, detached teeth was found.

The œsophagus leads into a dilatation of moderate size, which may be called the stomach. From it extends a diverticulum on either side which supplies two cerata. Posteriorly the stomach is prolonged into a very wide sacculated gut, which extends to the extreme end of the body and gives off simple diverticula, each of which supplies a single group of cerata. These diverticula fill the cerata entirely, and no cnidocysts were found. The contents of the digestive tract, including the cerata, resemble hardened jelly, and are probably composed of the eggs of fish, which the animal is said to eat. In this jelly are embedded moderately hard black lumps, detachable from their surroundings and easily friable, which the jelly is not. As mentioned above, in some specimens this black substance forms the major part of the contents of the digestive tract.

The lobes of the hermaphrodite gland are white, and visible through the dorsal integuments. They are composed of small pouches containing ova, scattered rather irregularly round a larger and more elongate pouch containing spermatozoa, and they alternate with the diverticula proceeding from the alimentary canal to the cerata. There is no armature on the penis. The renal organ consists of a simple sac with a few constrictions. It does not in my specimens extend so far backwards as is indicated by Hecht's figures (**1**, pl. iv, figs. 47, 48), but terminates soon after the commencement of the posterior third of the body.

While the present work was going through the press, Mr. Evans, Lecturer in Zoology at the University of Sheffield, made some careful and prolonged researches into the anatomy and physiology of *Calma glaucoides*.[1] He has most courteously communicated to me the results, which he has tested by the examination of numerous specimens. They are unexpected and of exceptional interest. He finds that *C. glaucoides* has a very spacious stomach but no intestine and no anal opening, the excreta (which owing to the nature of the food are relatively small in quantity) being retained within the body in the form of the black matter mentioned above. In young specimens in which the hermaphrodite loculi were immature, the sections showed recognizable remnants of fish embryos. In older animals containing mature ova and partially emptied male loculi, the contents of the stomach and of the hepatic diverticula in the cerata were highly vacuolated and comprised *inter alia* black or brown excrement. In other specimens the alimentary canal contained nothing but this dark excrement. Old specimens twice the size of those mentioned were found to be gorged with albumen, which was uniform and unvacuolated except for a black core of excrement running through the whole length of the stomach. Mr. Evans thinks that the animals live two years and that this stage represents the second year. To the best of my belief this arrangement of the alimentary organs has no parallel among the Mollusca. It seems to depend on the exceptional quality of the food, nearly the whole of which can be assimilated.

Mr. Evans further notes that the cerebro-pleural ganglia are fused and of the same size as the pedal ganglia, which lie at the sides of the œsophagus. There are no visceral ganglia as in the Ascoglossa. The buccal and rhinophorial ganglia are large, the latter sessile on the cerebro-pleural ganglia. The gastro-œsophageal ganglia consist

[1] It is of course possible that *Forestia mirabilis* may not possess the same peculiarities as *Calma glaucoides*. If so, the two genera will still have to be kept distinct.

of two to three ganglion cells. The eyes are sessile and the otocysts contain a single otolith apiece. The hermaphrodite gland is segmentally arranged in the spaces between the liver diverticula. Each segment contains a male loculus which is studded with female acini and which opens into a longitudinal hermaphrodite duct running along the median line below the kidney. The mucus gland is of the type usual in Æolids. The single spermatotheca opens into the *atrium* but does not communicate with the upper oviduct as in *Æolidia papillosa*. The male and female orifices are separate, much as in *Fiona*, the former lying in front of the first row of papillæ, the latter between the first and second rows. The penis is retractile into a sheath which runs longitudinally between these two openings and is indicated externally by a bulging ridge.

STILIGER BELLULUS (d'Orbigny).

= *Calliopæa bellula*, d'Orbigny, Mag. de Zool., 1837, pp. 12—14.
Stiliger mariæ Bergh **2**, pp. 137—144; *id.* **13**, pp. 12—17.

Bergh has published two detailed descriptions of this species, from which it appears that it resembles *Hermaea* in its internal structure. There is no *ingluvies buccalis;* there are two main liver-canals which enter the stomach one on each side and give off branches which enter the cerata. The genitalia are very complicated, and comprise two receptacula seminis and two accessory ramified glands.

It would appear that this species ought to be called *St. bellulus*, not *St. mariæ*. The genus was created by Ehrenberg (1831) for an animal found in the Red Sea and having the same external characters as this species, though the radula is unknown. Until the original *Stiliger ornatus* (not *modestus*, as it is sometimes quoted) is re-examined, some doubt must exist as to the identity of *Calliopæa* and *Stiliger*, though that identity is highly probable.

In 1837 d'Orbigny gave the name of *Calliopæa bellula* to a mollusc whose external characters are quite recognizable from his description. In 1865 Meyer and Möbius (Fauna der Kieler Bucht) described an apparently identical animal as *Embletonia mariæ*, wrongly regarding it as an Æolid. Bergh refers both forms to *Stiliger*, and brackets them together, but gives the preference to Meyer and Möbius's name, although d'Orbigny's name has undoubted priority if his species is admitted to be a *Stiliger*.

Through the kindness of Mr. Farran I have received three specimens from Ballynakil, Co. Galway. They are indifferently preserved, and have lost some or all of the cerata. The best specimen is 7 mm. long and has thirteen cerata remaining. They were apparently set in two rows and are of an ovoid shape. The posterior cerata of the inner row are relatively very large (2 mm. high). The rhinophores are distinct and white.

The ground colour is greyish white, with brownish or olive markings on the cerata and body. The foot is greyish white without markings. The opaque white internal organs, especially the hermaphrodite gland, can be seen through the integuments. When alive the animal appears to be like an *Embletonia*, whitish, but with rust-coloured mottlings on the back and cerata, which latter are stout and ovate. They are set in about five groups on either side, each group containing only one or two.

The radula contains five teeth in the ascending and twelve in the descending slightly spiral portion. They are as represented by Bergh, but so transparent that they are seen only with difficulty.

The species is recorded from West Ireland, the Atlantic coast of France, Kiel, and Trieste.

ALDERIA Allman.

Three species of this genus have been described.

1. *A. modesta* (Lovén).

2. *A. comosa* A. Da Costa. Naples (Ann. del Museo Zoologico, Napoli, anno iv, 1864, p. 32, and pl. ii, 3).

3. *A. harvardiensis* (Agassiz). East coast of North America (Gould **1**, pp. 254—255, pl. xvi, 226—228).

Alder and Hancock published some account of the anatomy of *A. modesta* in their Monograph, but only the external features of the other two species are known. *A. comosa* is green, with numerous long cerata, and the anal papilla lies behind the pericardium. It must be regarded as very doubtful if *A. harvardiensis* is really distinct from *A. modesta*. It differs in being darker, in having fewer and smaller cerata, and, if Gould's figure may be trusted, in the more angular shape of the head. But the description and the figure do not quite agree as to the disposition of the cerata, and the colour of *A. modesta* is very variable.

ALDERIA MODESTA Lovén.

(Plate VII, figs. 3—5.)

Alder and Hancock, Monograph, Genus 17, Fam. 3, pl. 41; Eliot **1**, pp. 376—379, and plates, in which some additional figures illustrating the anatomy are given.

I am indebted to Mr. W. I. Beaumont for several specimens of this interesting form, labelled "Ardfry, County Galway, May, 1904." In some unpublished MSS. of Albany Hancock preserved in the Hancock Museum at Newcastle-on-Tyne I have found the following notes on the living animal:

"The foot exhibited beautiful dendritic markings.[1] The glands in the papillæ are considerably branched. The animal yields a quantity of mucus, has a strong sugar smell, and is sluggish in its motions. The papillæ are remarkable for their rhythmical pulsations. They dilate and contract simultaneously between thirty and sixty times a minute. The contraction is very forcible, the posterior surface of the papillæ being most contracted. This pulsation has all the appearance of being connected with the circulation. The papillæ are much depressed when in a state of contraction."

The colour of the preserved specimens varies from white to yellow, with darker mottlings on the back and upper side of the cerata. The variations in shade are consider-

[1] Due apparently to the ramified diverticula of the alimentary canal being seen through the semi-transparent sole.

able. Sometimes the ground colour is yellowish and the mottlings light, leaving a general impression of yellowish brown. Sometimes the mottlings are thick and dark and the ground colour opaque white. The upper surface then appears to be purplish black, with a few white markings.

The animals are stoutly built, the largest specimens measuring 5·5 mm. by about 3·5 mm. In front the dorsal surface is bare, the cerata being set only at the sides, but behind they close over the body. The foot is white, broader than the body, with an expanded margin, but rather straight in front. No anterior groove is visible. Hancock made several drawings of the animal, besides those here reproduced, which indicate that the shape of the frontal margin varies considerably. It is sometimes represented as straight and sometimes as notched or bilobed. Probably the animal when alive can alter its outline.

At the sides there is a groove between the body and this margin, so that the body, though narrower than the foot, partly overhangs it. On this lateral projection of the body are set the cerata in three not very regular longitudinal rows. As a rule only two rows are fully developed, and the third, which consists of smaller cerata, has the appearance of being crowded in. The total number of cerata on either side does not appear to exceed fifteen, which is less than the number shown in Alder and Hancock's plates. The cerata are somewhat ovate in shape. Those behind are larger and more inflated than those in front. They contain ramified hepatic diverticula which bear primary and sometimes short secondary branches.

The head bears on each side a rounded prominence, but there are neither rhinophores nor tentacles in the ordinary sense. The anus is on a prominent papilla in the mediodorsal line and nearly terminal.

There is no trace of jaws. The radula is ascoglossan and short, containing five or six teeth in the ascending, and about as many in the descending portion. In an irregular heap lie about seven teeth of varying size, and with them a mass of minute spines, apparently representing the first teeth. The mature teeth are large and spoon-shaped. The outline is rather irregular, and there are generally two more or less distinct projections on the back.

There is no crop attached to the buccal mass, but from it issues a thin tube which must apparently be regarded as equivalent to a stomach as well as to an œsophagus, at least in its posterior part, for from it arises the intestine. This is a larger tube which bends slightly to the right and then runs directly backwards at first on the right under the side of the pericardium and finally above the renal organ to the anal papilla. The thin tube issuing from the buccal mass bears two folds inside. At its posterior extremity these folds become more numerous, and the tube bends downwards and dilates into a large stomach-like pouch. It is clear, however, that the intestine does not issue from this pouch, but from the narrower tube. It is probable that the animal lives on vegetable juices, and that the two folds in the tube act as strainers and valves, establishing communication alternately between the mouth and the pouch and between the pouch and the intestine, only one line of communication being open at a time. The pouch is prolonged anteriorly under the œsophagus, and divides into two diverticula which enter the anterior lobes of the foot. Posteriorly it extends almost to the end of the body and gives off two

sets of ramifying diverticula. The upper diverticula (about four in number) enter the cerata and are also ramified in the body. The lower diverticula (also about four) extend downwards through the hermaphrodite gland and do not enter the cerata, but their ramifications within the body create the peculiar dendritic markings visible through the sole of the foot.

The central nervous system (Pl. VII, fig. 6) forms a collar round the œsophagus consisting of seven principal ganglia close to one another and connected by very short commissures, the longest being that connecting the cerebral ganglia. They should probably be regarded as two cerebral, two pedal, and three visceral ganglia. Connected with the cerebral ganglia are two smaller ganglia, probably rhinophorial in function and innervating the most sensitive part of the head, although no external rhinophores are developed.

The hermaphrodite gland is large and ramified throughout the whole lower part of the body, filling up the interstices between the other organs. The ampulla and duct of the gland are short. After the bifurcation of the male and female branches the former runs to an orifice at the right anterior corner of the head. The vas deferens is not very long or much convoluted. A rather large prostate opens into it by several ducts. The penis is armed with a rather long curved spine, which in some specimens at any rate points inwards when the organ is retracted. Shortly after the bifurcation the female branch receives a long duct into which open the follicles of the albumen gland. This gland, like the hermaphrodite gland, is extensively ramified, especially in the last fourth of the body. Close to the entry of this duct and lying anteriorly is a pouch-like diverticulum which is probably a spermatotheca. No second spermatotheca was found. The female branch here makes a sharp turn and runs backwards nearly to the end of the body; it then doubles on itself and runs forwards, opening anteriorly close to the male orifice. All this section of the female branch after the spermatotheca is very much larger than the other parts and provided with remarkably thick glandular walls. It should probably be regarded as the uterus passing through the mucus gland. It is one of the largest and most conspicuous organs in the animal, and when sections are cut it generally expands and overlaps the heart and kidney.[1] This, however, appears to be the result of the disturbance caused by the cut, and not a natural arrangement. It is noticeable that near the bifurcation of the male and female branches there arises a cæcum which extends anteriorly and reaches the integument, but without forming any orifice. Pelseneer states (**1**, p. 62) that in *Elysia* the second female orifice is developed later than the others and is not found in young individuals. It is conceivable that this cæcum in *Alderia* may ultimately open externally.

The pericardium appears to be as usual and is medio-dorsal. The renal organ lies below it and is entire in the front, but the posterior portion gives off ramifying tubes, some of which extend into the cerata.

Blood lacunæ are distributed throughout the body, including the foot. The largest lie one on either side of the renal organ below the cerata, into which they send up long diverticula; the main portion of these diverticula lies on the posterior side of the cerata,

[1] This dislocation seems due to the elasticity and expansive power of the tissues which form the walls of the uterus.

which no doubt accounts for the peculiar pulsation and contraction noticed by Alder and Hancock in this part.

ELYSIA VIRIDIS (Montagu).

(Plate VII, figs. 1 and 2.)

Alder **1**, pp. 31—32. Bergh **29**, pp. 178—185. Meyer and Möbius **1**, pp. 7—10. Pelseneer **1**, pp. 57—62.

The two drawings are by Alder. His description of the animal is as follows: "Body ovate-oblong, depressed, grass-green with bright azure or bluish-green spots of a metallic lustre; tentacles ear-shaped, obtuse, dark green, frequently reflecting a purplish hue; the darker colour is frequently continued over the head and on the upper and outer side of the lateral lobes of the body, which are margined with white. A whitish space surrounds each eye, and the elevated region of the heart is also pale; the lateral expansions rise up in a curved line towards the middle of the back and diminish gradually to the tail; their inside is paler than the out and beautifully veined with green from the hepatic vessels[1] appearing through. Length 0·75 mm. Habitat on *Codium tomentosum*, *Zostera marina*, and other green seaweeds, in tidal pools, or occasionally in shallow water, especially on the south and west coasts.

"Var. *olivacea*.—Dark greenish, or purplish brown, spotted with blue and red dots, the edges of the mantle and tips of the tentacles being white. Habitat, Lochmaddy (M'Intosh) and Kiel Bay (Meyer and Möbius)."

This form seems to be the *Elysia minuta* recognized by Bergh as a separate species.

Alder's figures do not represent what I believe to be the commonest variety of *E. viridis*, in which the wing-like expansions are considerably broader, the light dots less conspicuous, and the inside of the wings is more markedly veined. But as far as the shape goes, some specimens preserved at Plymouth justify the figure, for in the preserved state they are 9 mm. and 11 mm. in length and only measure 2·5 mm. and 3 mm. respectively from the foot to the margin of the wings.

The structure and anatomy of *E. viridis* have been described by Souleyet in 'Le Voyage de la Bonite,' by Pelseneer, by Bergh, and by Meyer and Möbius. The specimens figured by the last-named authors belong to the variety *olivacea*.

The following points are extracted from these descriptions, in which, however, there are some discrepancies:

The nervous system consists of seven ganglia very clearly separate, round or somewhat oval in shape.

The buccal mass is relatively large, but there is no *ingluvies buccalis*. The radula consists of about ten teeth in the ascending part, about twenty in the descending, and about twenty more in the ascus or sack. They are of the form described as dagger-shaped, but with cavities enabling them to fit into one another (see Meyer and Möbius's

[1] It is probable that this expression is incorrect, and that Alder means the vein-like ridges which radiate from the pericardial prominence.

plates). Each bears about eighty minute denticles on the lower edge. The salivary glands are long and folliculate.

The stomach is small. The liver-system opens into it by one duct, which bifurcates first right and left and then again into anterior and posterior branches. Both branches are elaborately ramified and the ramifications extend among the genitalia and into the wings and tentacles.

On the dorsal surface can be seen the rather large and prominent pericardium and a system of thread-like ridges, which appear to be veins passing to the auricle through the kidney. The kidney lies below, but also partially surrounds the pericardium, with which it communicates by several (more than a dozen) orifices.[1]

The hermaphrodite gland is not a compact mass but a layer of diffuse follicles, which is divided into a right and left portion and extends throughout the greater part of the body. Its duct communicates with an oval body described as an ampulla. The ramifications of the hermaphrodite gland are accompanied by the ramifications of two other glands, one of which is described as a prostate and the other as albuminiparous (Pelseneer). But according to Bergh there is also a compact albumen and mucus gland. There is one spermatotheca. The verge is unarmed; both it and a female orifice (probably the oviduct) open behind the right rhinophore; another female orifice (probably the vagina) lies dextro-dorsally in front of the pericardium.

LIMAPONTIA NIGRA Johnston.

Alder **1**, pp. 28—29. Alder and Hancock **3**. Bergh **30**, pp. 207—209. Meyer and Möbius **1**. Pelseneer **1**, pp. 62—64.

This genus and its species are not mentioned in the Monograph, but were dealt with pretty fully by Alder and Hancock in the paper referred to above, which also contains black and white figures. For a coloured figure of *L. nigra* see Meyer and Möbius's plate.

Alder's description of the animal is as follows: "Body smooth, rather depressed, nearly linear when extended, but very contractile; the sides slightly overhanging the feet; head truncated in front and flat at the sides, except where it is elevated into two crest-like ridges, arched from behind forwards, on the sides of which posteriorly the eyes are placed in a pale circular space which is prolonged into the crest. Vent subposterior. The general colour is black, but sometimes individuals are found transparent and nearly colourless, showing the greenish biliary organs through the skin. Length 0·14 mm."

L. nigra is generally distributed over our coasts and is most commonly found on *Confervæ* in rock pools between tide-marks. It is gregarious and is said to emit a peculiar sweet smell when bruised.

Little has been added to our knowledge of this minute form since Alder and Hancock's article, although it has been examined by Bergh, Meyer and Möbius, and Pelseneer. The last named has published figures of the nervous system, genitalia, and various sections.

[1] So Pelseneer. But Hecht **1**, pp. 645 ff, denies this.

The radula is short and does not consist of more than twenty teeth, besides those in the ascus. The teeth are spoon-shaped and not denticulate. Meyer and Möbius's plate represents them clearly. The œsophagus is long, the stomach small. The liver forms two slightly ramified canals, extending from the buccal mass to nearly the end of the body on either side and united above the stomach by a transverse bar. In front of the buccal mass are small lobed salivary (or ptyaline) glands. The intestine is short and runs from the left-hand side of the stomach to the anal papilla which is medio-dorsal, a little behind the centre of the body.

There are no branchiæ of any sort, respiration being performed by the whole surface of the skin. The heart is medio-dorsal and of the usual structure. The kidney, which is small and not ramified, lies behind it. It does not open into the pericardium by multiple orifices.

The genitalia are much as in *Elysia*. The hermaphrodite gland is flocculent and diffused throughout the hinder part of the body. The tubular "albuminiparous" gland is also ramified, but the prostate is compact. There is a single spherical spermatotheca and three external orifices.

LIMAPONTIA DEPRESSA A. & H.

(Plate VII, figs. 7—9.)

Alder **1**, p. 29. Alder and Hancock **3**.

Alder's description is as follows: "Body oblong-ovate, depressed, swelling behind the centre and terminating in a blunt point posteriorly; black, generally with minute yellowish-white spots or freckles. Head rounded in front and slightly angulated at the sides; the lateral crests less elevated than in *L. nigra*, with the eyes situated in a white oblong area at each side of them. Vent placed in a depression at the posterior extremity of the body. Length 0·4 mm. Habitat: On *Conferva* in brackish water; near Sunderland and Swansea."

The species appears not to have been found since the time of Alder and Hancock. It differs from *L. nigra* in being larger, flatter, and wider, and almost shows a commencement of wing-like expansions as in Elysia. Owing to this greater breadth there is room for a much more considerable ramification of the liver, which can be seen through the sides in fig. 8. The vent is almost terminal, and placed in a groove at the end of the dorsal surface.

ACTEONIA CORRUGATA A. & H.

Alder **1**, p. 30. Alder & Hancock **3**, p. 404.

Alder's description is as follows: "Body nearly linear, rather short and stout, regularly wrinkled in a longitudinal direction; black, excepting the carina and tail, which are whitish. Head carinated at sides, each carina being produced into a short, flat, whitish tentacular process. Eyes placed in circular white spots behind the carinæ.

There is a slightly raised ridge on each side of the back, in the region of the vent. Length 0·12 mm. Habitat: rare; found by Mr. Cocks at Falmouth feeding upon *Conferva glaucescens* in company with *Limapontia nigra*."

I have not seen this species alive, but have examined a preserved specimen purporting to belong to it and found at Plymouth.[1] Except that it has become uniformly black and shows no white markings it corresponds fairly well with the above description. The body is wrinkled longitudinally and also bears a low ridge on either side of the visceral hump. There are two other small ridges on the head, each of which is produced into a short tentacle. The radula is transparent and composed of thirteen teeth, six in the ascending and seven in the descending part. There are twenty in the heap. They are of the spoon-like shape common in the family, but in all the teeth there is a small indentation on either side of the end of the spoon, producing a small denticle. The verge is armed with a short curved spine. The specimen was about 4 mm. long and too hardened for anatomical examination, but the liver and hermaphrodite gland seemed to be as in *Limapontia*.

CENIA COCKSI A. & H.

(Plate VII, figs. 10 and 11.)

Alder **1**, pp. 30—31. Alder and Hancock **3**, p. 404. Pelseneer, La condensation embryogénique chez un Nudibranche, in Trav. Zool. Wimereux, tome vii, pp. 513—520.

Mr. Elmhirst has kindly sent me from Millport a fine specimen of this Nudibranch which appears not to be common on our coasts. It is active in its movements when in the water, but frequently crawls outside and reposes about an inch above the water. It lived about ten days in confinement, apparently in perfect health and vigour, until it was killed.

When crawling it is about 6 mm. long and 2 mm. broad, but frequently contracts into a spherical shape with a diameter of about 3·5 mm. The rhinophores are thin and distinct, about 1 mm. long. The pericardium is moderately prominent in the middle of the back. No orifices are visible, but the verge projects just behind the right tentacle. The dorsal spots are not raised, and except the rhinophores there are no appendages or prominences of any kind,[2] but when the animal moves wave-like ridges often pass temporarily over the skin.

The body-colour is dark purplish brown, and under a lens is seen to be composed of numerous minute spots and granules. In the centre of the back is a yellow spot, and on either side are four others. The rhinophores are yellow, and yellow lines, which when the animal is extended form ridges, run from the rhinophores to the front of the head.

The sole also is clear transparent yellow and allows the intestines to be seen. The

[1] A second living specimen sent to me from Plymouth while this work was going through the press seems to me to be really *Cenia cocksi*, and I do not feel sure that I have ever examined a true *Acteonia*.

[2] But Alder (*l. c.*, p. 31) says: "On each side of the back near the vent is a slight ridge." I could not see it.

tail is 1·25 mm. long, and yellow. It is distinctly separated from the dark dorsal hump. The viscera are entirely contained in this hump and do not extend into the tail.

With only one specimen of a small animal it was difficult to ascertain much about the anatomy, but the following points seem certain: The radula is of the usual ascoglossan type and contains five teeth in the ascending portion, seven in the descending, and about thirty of very various sizes in the heap. They are of much the same shape as in *Alderia*, but with a very distinct kink in the lower part of the back. The front part is spoon-shaped, and sometimes (but not always) contracted and prolonged into a sort of nose. The lower edge is not denticulate, but the outline is often wavy and indented.

The short yellow œsophagus dilates into a small stomach. The liver is dark green, not much ramified, and, as far as could be ascertained, resembles Alder and Hancock's figure [1] of *Limapontia nigra* in all essential points, but it enters the stomach further forward than those represented, and runs towards the head right under the eyes. These latter are large and distinct. The nervous system unfortunately could not be disentangled. The hermaphrodite gland consists of seven large spherical globules connected by white tubules. It lies under the liver. Nothing more could be ascertained about the genitalia, and no stylet was found on the verge, but its absence cannot be considered certain. Pelseneer (*l. c.*) has discovered that the development follows a course to which no parallel is known among Nudibranchs. The larval stages are passed entirely in the egg, and the animal issues not as a veliger but with the form of the adult. This peculiarity is probably connected with its semi-terrestrial habits.

Alder and Hancock originally called this animal *Ictis*, but finding that this name was preoccupied changed it to *Cenia*. They at first recognized two genera, *Acteonia* and *Cenia*, but Alder subsequently united them under the former name, considering that the difference in the shape of the tentacles was not sufficient as a generic characteristic. As far as his information went he was probably right, but after Pelseneer's discovery it is better to separate the two genera unless it can be shown that the development of *Acteonia* (of which nothing is known at present) follows the same course. *Limapontia*, though superficially very like *Cenia*, has a totally different life-history since it issues from the egg as a free-swimming, shell-bearing, operculate veliger.

[1] *L. c.*, pl. 20, 1.

SYNOPSIS OF FAMILIES, GENERA, AND SPECIES FOR THE NUDIBRANCHIATE FAUNA OF THE BRITISH ISLES.

Forms or groups enclosed in square brackets have not been recorded as occurring in British waters, but are found in the adjacent parts of the north-eastern Atlantic and probably inhabit or visit some part of our coasts. Nudibranchs have been systematically collected in comparatively few localities of the British Isles, and since these, including the Channel Islands and Shetland Islands, extend from 49° to 62° lat. N., it is probable that they possess almost the whole fauna found on the Atlantic coast of Europe from France to Scandinavia. Only families occurring in the northern Atlantic are included in the following list, and hence the numbers do not correspond with those given in the lists which take account of the whole group.

A. HOLOHEPATICA.

Liver in a single mass.

Family I. **TRITONIIDÆ.**

Branchiæ consisting of tufts set along the mantle-margin or occasionally altogether absent. One spermatotheca.

Genus 1. **Tritonia** Cuv.

See especially Bergh **40**, pp. 698—736.

The body is limaciform but somewhat rectangular in outline, except at the end where it tapers to a short tail. The foot is broad. Over the mouth is an oral veil bearing two grooved tentacles at the ends, and in the middle tubercles or processes. The rhinophores are retractile into raised sheaths; not perfoliate but surrounded by a few plumes. The dorsal margin is slightly prominent and bears a single row of branchial tufts which are more or less arborescent. Anal and renal openings on the right side. Jaws large, with several rows of denticles or prominences near the edge. The radula varies greatly in size in the different species, but always consists of a broadish central tooth with a moderate or large number of laterals which are usually simply hamate. The first lateral is usually larger and lower than the others and somewhat clumsily shaped. The liver is not divided and sends off no branches to the gills. There is no

armature either in the stomach or on the genitalia. The hermaphrodite gland forms a layer spread over the liver.

Numerous descriptions of various species have been published. See especially Bergh's monograph referred to above.

The genus has been divided into *Tritonia sensu stricto* and *Candiella*. The former comprises rather large and stout animals with broad radulæ and small tubercles or papillæ on the oral veil, whereas the name *Candiella* is given to smaller and more slender forms which have a narrow radula but bear moderately long digitations on the oral veil. But the two sections run into one another and cannot be regarded as having more than subgeneric rank, nor do the characters of a digitate veil and narrow radula always go together. *Candiella ingolfiana* Bergh has a radula of 67 × 84.1.84, whereas *Tritonia challengeriana* Bergh has one of only 43 × 45.1.45.

Marionia Vayssière is distinguished from *Tritonia* by having the stomach armed with hard plates. The processes on the oral veil are generally branched, and the branchiæ are often very ample. This genus is frequent in the Mediterranean and warm waters, but has not yet been recorded from the northern Atlantic.

Section **Tritonia sensu stricto.**

1. T. hombergii Cuv.
   (*Pl.* 7, *Fam.* 2, *Pl.* 2.)[1]

Section **Candiella.**

2. T. plebeia Johnston.
   (*Pt.* 3, *Fam.* 2, *Pl.* 3.)
3. T. lineata A. & H.
   (*Pt.* 5, *Fam.* 2, *Pl.* 4.)
4. T. alba A. & H.
   (*Pt.* 8, *Pl. I*, *fig.* 10.)

The last species, on account of its remarkable radula, has at least as good a claim to be the type of a sub-genus as *Candiella*.

[Two other species are recorded from the northern Atlantic but are little known. *Tritonia psoloides* Aurivillius (see Vega Expedition, p. 381) has a warty and reticulate back and a narrower radula (80.1.80) than *T. hombergii*. *Candiella ingolfiana* Bergh is known from a single preserved specimen obtained in deep water, 61° 44′ lat. N. and 27° long. W. It is about 5 centimetres long, and as preserved bluish grey with yellow colouring on the head, foot, and rhinophores. It has twelve to fourteen small branchiæ and twelve digitations on the oral veil. The first lateral tooth of the radula is denticulate.

Bergh (**54**, pp. 22—26) created the genus *Atthila* for a remarkable animal, found

[1] The references are to the plates of the Monograph.

in deep water, 62° lat. N. 21° 36′ long. W., which resembles *Tritonia* in many respects but has the following peculiarities: (*a*) there are three rows of appendages on the dorsal surface; (*b*) the oral veil is large but has a smooth margin; (*c*) the rhinophores are perfoliate; (*d*) in the buccal parts the edge of the jaws is smooth; the central tooth of the radula and the first lateral are not denticulate. The structure of the liver and hermaphrodite gland is not quite clear from the published description, but is apparently not the same as in *Tritonia*. The only known species, *Atthila ingolfiana* Bergh, is said to have been of a pale flesh colour when alive.]

Family II. **DORIDIDÆ CRYPTOBRANCHIATÆ.**

Branchiæ retractile into a permanent pocket. Two spermatothecas.

Genus 1. **Doris**[1] L.

Animals not hard, flattish, but the back is usually moderately arched. The dorsal surface is covered with tubercles or warts which are sometimes specially developed round the openings of the branchiæ and rhinophores. Tentacles often thick, grooved projections. Foot broad. Mantle-margin not narrow. Radula broad and composed of simply hamate teeth. No armature on the labial cuticle or the male genitalia.

This genus is distinguished by the shape, the tuberculate back, and the buccal parts. As a rule there is no labial armature at all, and if traces of it are sometimes found it is only rudimentary.

Sec. i. **Staurodoris** Bergh.

Tubercles large and club-like, sometimes connected by ridges and specially developed so as to protect the branchiæ and rhinophores. Branchiæ usually pinnate or bipinnate.

In typical forms these characters are very distinct, but they vary considerably even within the limits of one species.

1. D. verrucosa Cuv.
   (*Pt.* 6, *Fam.* 1, *Pl.* 11.)
2. D. maculata Garstang.
   (*Pt.* 8, *Pl. VIII, figs.* 6, 7.)

Sec. ii. **Archidoris** Bergh.

Tubercles smaller than in *Staurodoris* and not specially developed to protect the branchiæ and rhinophores, though they sometimes form a circle round the pockets. Branchiæ usually tripinnate, more rarely bipinnate.

[1] Full references to the literature are given in the descriptions of the various species, pp. 96—99.

3. Doris tuberculata Cuv.
(*Pt.* 6, *Fam.* 1, *Pl.* 3.)
4. D. flammea A. & H.
(*Pt.* 1, *Fam.* 1, *Pl.* 4.)

In A. and H.'s preparation of the radula the teeth have long bases, and are stouter and more erect than in *D. tuberculata*.

5. D. testudinaria Risso, but redescribed by A. & H.
= D. stellifera von Jhering.
(*Pt.* 8, *Pl. I, figs.* 5—9.)

[*D. nobilis* Lovén (MS.) is regarded by Odhner (**1**, p. 20) as a separate species distinguished from *D. tuberculata* by having three longitudinal series of larger tubercles down the centre of the back. The colour is light reddish, becoming yellow near the mantle-margin. It is recorded from Scandinavian waters.]

Genus 2. **Geitodoris** Bergh.

See Bergh **50**, pp. 162—166.

Flattish, back granulate. Tentacles conical. Branchiæ tripinnate. A labial armature of small rods is present, and the teeth of the radula are of two kinds: the ten or fifteen which are nearer to the rhachis in each row are of the ordinary hamate shape, but the outer teeth are extremely thin and crowded together in bundles.

1. G. planata (A. & H.).
(*Pt.* 3, *Fam.* 1, *Pl.* 8.)

See above and Eliot **1**, pp. 340—341, and 344—345; also Eliot in Proc. Malac. Soc. of London, 1904, vol. vi, pp. 180—181.

Genus 3. **Aporodoris** von Jhering.

See von Jhering, Zur Kenntn. d. Nudibr. d. brasil. Küste in Malacolog. Jahrb., xiii, 1886 pp. 238—239.

This somewhat uncertain genus was created by von Jhering for Alder and Hancock's *Doris millegrana*, which he identified with specimens found by himself in the Mediterranean. His diagnosis of the genus is as follows:—

Corpus sat molle subdepressum, supra granulatum et minute tuberculatum. Aperturæ rhinophoriales margine crenulato. Tentacula digitiformia. Podarium margine anteriore bilabiatum, labio superiore profunde fisso. Branchia retractilia. Armatura labialis nulla. Radula rhachide nuda, pleuris multidentatis, hamatis, externis pectiniformibus. Penis inermis.

Von Jhering discusses (*l. c.*) five genera, *Thordisa* Bgh., *Halgerda* Bgh., *Dictyodoris* Bgh., *Etidoris* von Jher., and *Aporodoris* von Jher., to which might be added *Diaulula* Bgh., nearly related to *Thordisa*, if not identical with it. It is fairly certain that some of these genera are superfluous, and as *Aporodoris* is the latest in date the name is not likely to be maintained, but it is here kept provisionally as it is impossible at present to say with which genera either of von Jhering or of earlier authors it will be amalgamated.

1. Aporodoris millegrana (A. & H.).

Genus 4. **Jorunna** Bergh.

See Bergh **16**, p. 346; **18**, pp. 195—201; **40**, pp. 683—685; **46**, pp. 113—128; Garstang, Notes on *Jorunna Johnstoni* in Conchologist, vol. ii, pt. 3, 1892.

Soft and minutely granulate. Tentacles distinct, finger-shaped. Branchiæ tripinnate. Foot broad; its anterior margin is deeply grooved and the upper portion is divided in the middle so as to form two flaps or lappets which are ampler than in most genera. The branchiæ form a symmetrical cup. No labial armature. Most of the teeth are simply hamate, but a few (three to five) of the outermost are long and thin. The vestibulum genitale contains four openings: (1) ♂, (2) for the bursa copulatrix, (3) for the mucus gland or uterus, (4) for a special gland armed with a spine.

Jorunna is probably not distinct from *Kentrodoris* Bergh (see Bergh **35**, pp. 415—442; **43**, 921—924), which has the same structure of the foot, but has (*a*) a long spine on the verge, (*b*) a slightly different radula, inasmuch as the outermost teeth are not markedly longer than the others, as in *Jorunna*, and the innermost sometimes have an accessory denticle. *Kentrodoris* and *Jorunna* were both created by Bergh in the same year, but it would appear that *Kentrodoris* has priority. I do not, however, propose to supersede the name *Jorunna*, which has been generally accepted for the European forms, until the identity has been shown to be certain.

1. J. johnstoni (A. & H.).
(*Pt.* 1, *Fam.* 1, *Pl.* 5.)

Genus 5. **Rostanga** Bergh.

See Bergh **16**, p. 353; **46**, pp. 99—107.

Back covered with hispid papillæ. Branchiæ simply pinnate and rather numerous (nine to ten). A labial armature of rods. The radula contains teeth of two kinds: those nearer to the centre are hamate, fairly stout, and sometimes bicuspid or denticulate; those nearer to the end of the row are long and thin, usually bifid or provided with a few long denticles.

1. R. coccinea (Forbes).
(*Pt.* 4, *Fam.* 1, *Pl.* 7.)

Genus 6. **Aldisa** Bergh.

Bergh **16**, p. 348; **53**, pp. 7—10; **54**, pp. 5—7; G. O. Sars **1**, p. 305 and pl. 27; Vayssière **2**, pp. 27—30.

Dorsal surface tuberculate. Tentacles represented by small lumps. Branchiæ tripinnate. No labial armature. Radula with no central tooth but numerous side teeth, which are erect, thin, not much hooked, and serrulate. In *A. zetlandica* the verge is armed with spines; in the Mediterranean species, *A. berghi* Vayssière, it is unarmed.

1. A. zetlandica (A. & H.).
(*Pt.* 8, *Pl. I, figs.* 3, 4.)

Genus 7. **Cadlina** Bergh.

See Bergh **18**, pp. 170—180; **50**, pp. 168—171.

Dorsal surface as a rule granulate or bearing small tubercles. Tentacles short, broad, and flat. Foot broad. Labial cuticle armed with a plate or band composed of minute hooks. The rhachis of the radula bears a median denticulate tooth; the lateral teeth are hamate and denticulate. In most species (but not in *C. claræ*) the verge is armed with rows of minute hooks.

C. repanda is the only species recorded from British waters, but it is not improbable that *C. glabra* and *C. claræ* may also occur on our coasts. It is also possible that when better known they may prove to be varieties of *C. repanda*.

1. C. repanda (A. & H.).
(*Pt.* 3, *Fam.* 1, *Pl.* 6.)

Perhaps = *Doris lævis* L. and *D. obvelata* O. F. Müller, but it is difficult to prove the identity.

[2. C. glabra (Friele & Hansen).

See Friele and Hansen **1**, p. 70.

White with yellow branchiæ and rhinophores. Smooth. Radula 70 × 40.1.40.

3. C. claræ von Jhering.

See von Jhering, Mal. Blätter, ii Band, 1880, pp. 107—110; and Eliot **4**, pp. 44, 45.
White with dark brown rhinophores and branchiæ. Radula 70 × 23.1.23.
No armature found on verge.]

Family III. **DORIDIDÆ PHANEROBRANCHIATÆ.**

Branchiæ forming a dorsal tuft, but not retractile into a pocket. Two spermatothecas.

a. NOTODORIDIDÆ.

Radula broad; teeth uniform.

[Genus 1. **Triopella** G. O. Sars.

See G. O. Sars **1**, p. 310, p. 27, figs. 3 *a*—*d*.

This little-known genus was created by G. O. Sars for an animal described by M. Sars as *Triopa incisa*. The characters appear to be as follows:—

Mantle-margin ample, covering the sides and head, but interrupted behind. Oral tentacles inconspicuous; rhinophores perfoliate and retractile. Branchiæ a few small non-retractile tufts, protected by appendages which close over them. Integuments full of spicules. Dorsal surface bearing two ridges which converge in front, and a row of clavate processes at the sides and round the head. Jaws are not mentioned. Formula of radula about 20.0.20. Side teeth all similar and hamate.

1. Triopella incisa (M. Sars).

White. Characters as for genus. Length 7 mm.]

Genus 2. **Ægires** Lovén.

See Lovén, Öfvers. Vetensk.-Akademiens Förh., i, 1845, p. 49; and Ind. Mollusc., 1846, p. 6; Bergh **20**, pp. 23—32.

Ægires, not *Ægirus*, is Lovén's orthography.

Body rather stoutly built and tuberculate. Frontal veil and mantle-margin narrow and marked with a line of tubercles. Oral tentacles small. Rhinophores not perfoliate, provided with sheaths. Branchiæ few, tripinnate, protected by special lobes. Penis armed with spines. The labial disc bears a ring of rods; behind this is a single upper jaw as in *Limæ*. Radula about 20.0.20. Teeth all similar, and simply hamate.

1. Æg. punctilucens (d'Orbigny).
(*Pt.* 4, *Fam.* 1, *Pl.* 21.)

[2. Æg. hispidus Hesse.

Hesse, Journ. de Conchyl., 1873, p. 308.

Chiefly distinguished by its hispid and mobile tubercles. Frontal veil bilobed: ground colour reddish: tubercles greyish; branchiæ whitish.]

β. POLYCERIDÆ.

Shape generally limaciform with appendages. Teeth differentiated. Radula often narrow.

Genus 1. **Triopa** Johnston.

See Johnston, Miscellanea Zoologica, in Ann. Nat. Hist., 1838, p. 123; Bergh **20**, pp. 12—16.

Limaciform; pallial margin and oral veil narrow but marked by a line of moderately long papillæ, smooth or tuberculate. Oral tentacles grooved. Rhinophores perfoliate and retractile into short sheaths. Back usually tuberculate. Branchiæ few (three), not protected by special appendages. Penis armed with hooks. No jaws or labial armature. Formula of radula about 13 + 1 + 1 . 0 . 1 + 1 + 13. First lateral slender, hamate; second lateral larger and stouter with a double hook; remaining teeth flattish and plate-like.

1. Tr. clavigera (O. F. Müller).
(*Pt.* 4, *Fam.* 1, *Pl.* 20.)

[Genus 2. **Issa** Bergh.

See Bergh **20**, pp. 19—23.

This genus is hardly separable from *Triopa* in its external characters, and is distinguished by having the marginal processes shorter and the dorsal processes longer, so that the whole animal is sparsely studded with papillæ. But the buccal parts are different. There are two triangular jaws, and the formula of the radula is about 7 + 2 + 1 + 2 + 7. The central tooth is a flat plate; the first and second laterals are both large and of a clumsy hamate shape; the remaining teeth are flat plates.

1. I. lacera (Abildg.).
Body white; rhinophores and branchiæ yellow.]

Genus 3. **Crimora** A. & H.

See Alder **1**, pp. 73—74; Alder and Hancock **2**, p. 263.

Limaciform; mantle indistinct, forming a veil with branched appendages over the head and a pallial ridge which bears numerous filaments at the sides of the back. Oral tentacles tubercular; rhinophores laminated and retractile within sheaths. Branchiæ three, tripinnate. The radula contains four or five kinds of teeth: (1) An imperfectly hamate plate next to the rhachis; (2) a large bicuspid tooth; (3) a few imperfectly

hamate plates which gradually become (4) more distinctly hamate; (5) very long, curved, minutely serrulated, external teeth.

Some of the above characters may be merely specific, not generic. The original descriptions say nothing about the genitalia or labial armature, but the latter is probably absent.

1. Crimora papillata A. & H.
(*Pt.* 8, *Pl. II, figs.* 1—5.)

Genus 4. **Thecacera** Fleming.

See Eliot, Journ. of Conchol., vol. ii, October, 1905, pp. 241—242.

Body limaciform. Oral veil indistinct, smooth or tuberculate. No pallial margin. Rhinophores perfoliate, retractile into large sheaths. Branchiæ three to seven, tripinnate, with two lateral appendages. Penis armed with hooked spines (at any rate in *Th. maculigera*). Jaws with a wing-shaped process. Radula short with a formula of from 3 + 2 . 0 . 2 + 3 to 5 + 2 . 0 . 2 + 5. The two inner teeth are large and hamate; the rest flat and plate-like.

1. Th. pennigera Montagu.
(*Pt.* 7, *Fam.* 1, *Pl.* 21 *a.*)
2. Th. virescens A. & H.
3. Th. capitata A. & H.

Genus 5. **Polycera** Cuv.

See Bergh **19**, pp. 3—27; Meyer and Möbius **1**, pp. 49—56.

Body limaciform. Pallial margin not wide but marked by a tuberculate ridge at the side and continuous round the head, where it bears digitate processes or tubercles. Branchiæ simple, bi- or tripinnate, with one or more appendages on either side. Rhinophores perfoliate and contractile but without sheaths. Jaws with or without a wing-like process. Radula with a formula varying from 4 + 2 . 0 . 2 + 4 to 8 + 2 . 0 . 2 + 8. The two inner teeth are large and hamate; the others flattish. Penis armed with spines. Prostate large.

Gray divided the genus into two: (*a*) *Polycera sensu stricto*, in which the frontal margin is digitate, the dorsal appendages near the branchiæ two only and large, and the jaws have wing-like processes; (*b*) *Palio*, in which the frontal margin is tuberculate, the appendages near the branchiæ are small but several in number, and the jaws have no wing-like process. These divisions may perhaps be kept as sections, but they hardly amount to genera, and the differences are not so absolute as stated above. For instance in *Polycera quadrilineata* the branchial appendages are often palmate and subdivided or even several in number, and separate; the frontal veil sometimes bears numerous appendages of various sizes. (See, for example, Elmhirst, Annals Scottish Nat. Hist., 1908, pp. 228—230.)

(Polycera sensu stricto.)

1. P. quadrilineata (O. F. Müller).
(*Pt.* 5, *Fam.* 1, *Pl.* 22.)

P. plebeia Lovén, *P. horrida* Hesse, *P. doriformis* Quatref., and *P. canteriata* (Quatref.) seem to be merely varieties.

(Palio.)

2. P. lessonii (d'Orbigny).
(*Pt.* 4, *Fam.* 1, *Pl.* 24.)
3. P. ocellata A. & H.
(*Pt.* 2, *Fam.* 1, *Pl.* 23.)

It may be doubted if these two forms are more than varieties of one species, but Alder and Hancock insist on their specific distinctness.

γ. PSEUDODORIDIDÆ.

Shape doridiform. Radula varying from moderately broad to very narrow. Teeth differentiated. Ingluvies buccalis present.

[Genus 1. **Doridunculus** G. O. Sars.

See G. O. Sars **1**, p. 309.

This genus consists of two small and little-known forms recorded from the Scandinavian coast. The body is flat, the foot narrow; the mantle ample but not covering the tail. The back is covered with conical papillæ and also bears two parallel longitudinal ridges. The openings of the rhinophores are not raised or crenulate. The branchiæ are few and small, simply pinnate. No labial armature is mentioned. The radula is narrow. There is no median tooth; the first lateral is denticulate (or the first two), and is followed by five others in which the hook gradually decreases and disappears.

The dentition makes it probable that the genus is allied to *Acanthodoris*, but the characters are not fully described.

1. D. echinulatus G. O. Sars.

7 mm. long. Rhinophores and branchiæ yellow. Branchiæ 3. Radula 5 + 1. 0. 1 + 5.

2. D. pentabranchus Odhner.

Yellowish; 13 mm. long. Branchiæ 5. Radula 5 + 1 + 1 . 0 . 1 + 1 + 5. First lateral denticulate on both sides, second on outer side only. Remaining teeth not denticulate.]

Genus 2. **Acanthodoris** Gray.

See Bergh **18**, pp. 237—257; *id.* **43**, p. 988—990; **48**, pp. 93—99; Meyer and Möbius **1**, pp. 63—67.

Flattish doridiform animals. Back covered with papillæ or villi; margin of rhinophore openings not much raised, papillate or lobate. Head broad, semi-circular, expanded into tentacular lobes at the sides. Branchiæ tripinnate, set in a circle. The penis is usually armed with spines and the vagina is extremely long. The buccal crop is affixed directly to the buccal bulb, without any stalk. The labial armature is composed of hooks, but forms in its lower portion a cuticular plate which is often produced into two blade-like processes. The formula of the radula is $x + 1 \,.\, 0 \,.\, 1 + x$. The first lateral is very large, hamate and denticulate; the rest (four to eight in number) less perfectly hamate or flat.

1. Ac. pilosa (O. F. Müller).
   (*Pt.* 5, *Fam.* 1, *Pl.* 15.)

Recorded also from N. Pacific, Tasmania, and New Zealand.

2. Ac. subquadrata A. & H.
   (*Pt.* 5, *Fam.* 1, *Pl.* 16.)

Three very uncertain species, *Ac. stellata*, *Ac. citrina*, *Ac. ornata*, are described by Verrill from the Atlantic coast of America. The last should be easily recognizable if found again. It is said to have an angular oral veil with four processes, a smooth area in the middle of the back, long rhinophores and branchiæ which project beyond the body.

Genus 3. **Adalaria** Bergh.

See Bergh **18**, pp. 224—237; Meyer and Möbius **1**, pp. 69—70; A. and H. **2**, p. 262.

This genus, which was instituted by Bergh for the *Doris proxima* of Alder and Hancock, is intermediate between *Acanthodoris* and *Lamellidoris*. The radula resembles that of the former genus, but there is no labial armature. On the other hand the branchiæ are simply pinnate as in *Lamellidoris*, and the openings of the rhinophore sheaths smooth. The dorsal surface is tuberculate.

1. Ad. proxima (A. & H.).
   (*Pt.* 6, *Fam.* 1, *Pl.* 9.)
2. Ad. lovéni (A. & H.).
   (*Pt.* 8, *Pl. I, figs.* 1, 2.)

Genus 4. **Lamellidoris** A. & H.

See Bergh **18**, pp. 207—224; **39**, pp. 612—614; **48**, p. 101; Meyer and Möbius **1**, pp. 73—74; Eliot **1**, pp. 345—346.

The dorsal surface is granulate or tuberculate; the margins of the rhinophore openings are smooth. The head is broad, crescent-shaped, with the corners produced into

tentacular processes. The branchiæ are simply pinnate, rather numerous and set in a horse-shoe. There is no regular labial armature, but the oral cuticle is armed with a ring of papillæ and two ridges. The radula is very narrow, consisting of only two teeth on either side of the rhachis, the inner large and the outer small. There is sometimes a rather imperfectly formed median tooth and sometimes none at all. The main differences between this genus and *Acanthodoris* are found in (*a*) the branchiæ, which are simply pinnate, and (*b*) the buccal parts.

Sec. i. Radula with a median plate which is generally rudimentary.

1. Lamellidoris bilamellata (L.).
(*Pt.* 6, *Fam.* 1, *Pl.* 11).

2. L. muricata (O. F. Müller).

See Alder **1**, p. 88, and Monogr., p. 42, and Appx. ii.

= *Doris muricata* Meyer and Möbius, and *D. muricata* var. β Lovén (var. *a* being *Adalaria lovéni*). The radula contains 29 to 44 rows with a formula of 1 + 1 + 1 + 1 + 1. The inner teeth have large bases and about 16 denticles. The external teeth are small with a rudimentary hook.

3. L. diaphana A. & H.
(*Pt.* 2, *Fam.* 1, *Pl.* 10.)
4. L. aspera A. & H.
(*Pt.* 6, *Fam.* 1, *Pl.* 9.)

Sec. ii. Radula without a median plate.

5. L. sparsa A. & H.
(*Pt.* 4, *Fam.* 1, *Pl.* 14.)
See Garstang **1**, p. 179.
6. L. depressa A. & H.
(*Pt.* 5, *Fam.* 1, *Pl.* 12.)
7. L. inconspicua A. & H.
(*Pt.* 5, *Fam.* 1, *Pl.* 12.)
8. L. oblonga A. & H.
(*Pt.* 5, *Fam.* 1, *Pl.* 16.)

See Garstang in Journ. Mar. Biol. Assoc., vol. vii, p. 220. Faunistic Notes at Plymouth.

9. L. luteocincta M. Sars.
= Doris beaumonti Farran.
(*Pt.* 8, *Pl. II, figs.* 8, 9.)
10. L.? ulidiana Thompson.
(*Pt.* 8, *Pl. II, figs.* 6, 7.)

A number of doubtful species from the Atlantic have been referred to this genus. Bergh includes in his list four species from the Atlantic coast of North America (*Doris*

tenella, *D. pallida*, *D. diademata* and *D. grisea*), described in Gould **1**, pp. 229—232, and two from Arcachon (*D. derelicta* and *D. eubalia*) described by Fischer in Journ. de Conchyl., 1867, p. 7, and 1872, p. 10. But Fischer says that the branchiæ of *D. eubalia* are retractile, and it seems to me more probably referable to *Staurodoris*. Still more doubtful are the species described by Verrill from the Bermudas (*L. lactea*, *L. quadrimaculata*, *L. aureopuncta*, *L. miniata* and *L. olivacea*), several of which are said to have retractile branchiæ. It is also thought by some authorities that *D. diedemata* is a variety of *D. tuberculata*.

8. GONIODORIDIDÆ.

Body more or less limaciform, often with appendages. Rhinophores not retractile. Radula extremely narrow (only two or four teeth). Ingluvies buccalis present.

Genus 1. **Goniodoris** Forbes.

See Bergh **17**, pp. 115—137.

Body limaciform but somewhat stout and angular. Pallial margin not continuous behind. Back with tubercles and ridges. Head prominent and produced at the sides into large, flat, tentacular processes. Rhinophores not retractile. Branchiæ pinnate or tripinnate, and varying in number. Penis armed with hooks. Buccal crop attached by a short stalk. There is a labial armature formed of hooks or prominences, but it is often feebly developed. Formula of radula 1 + 1 . 0 . 1 + 1; inner tooth large, hamate, smooth or denticulate; outer tooth a small plate.[1]

1. G. nodosa Montagu.
   (*Pt.* 2, *Fam.* 1, *Pl.* 18.)
2. G. castanea A. & H.
   (*Pt.* 3, *Fam.* 1, *Pl.* 19.)

The distribution of *D. castanea* is remarkably wide. It is recorded from the Atlantic, the Mediterranean, New Zealand, and Suez. It has perhaps a special aptitude for migrating on the keels of ships.

[*G. danielseni* Friele and Hansen **1**, pp. 72—73, is a doubtful form, and perhaps not a *Goniodoris* at all. See G. O. Sars **1**, p. 364.]

[1] Bergh could find no blood-gland in this genus. Pelseneer, however, reports (**1**, p. 45) that it is present, and from an examination of preserved specimens I am inclined to agree with him. But the blood-gland and salivary glands are apt to become fused together in preserved material, and it is difficult to demonstrate the existence of the former if it is called in question.

Genus 2. **Ancula** Lovén.

See Lovén, Index Mollusc., 1846, p. 5; Bergh **20**, pp. 3—9; Meyer and Möbius **1**, pp. 59—61.

Body limaciform, smooth. No oral veil or pallial margin, but the place of the latter is marked by a row of papillæ in the branchial region. Oral tentacles distinct. Rhinophores perfoliate, not retractile, without sheaths, but with two tentacular appendages. Branchiæ few (three), tripinnate. Verge armed with hooks. Buccal crop sessile. Strong labial armature of hooks. The rhachis of the radula bears thickenings which do not amount to teeth; on either side are two teeth, the inner large, broad, and denticulate, the outer smaller and plain.

1. A. cristata Alder.
(*Pt.* 3, *Fam.* 1, *Pl.* 25.)

[*Ancula sulphurea*, from the coast of New England, described by Stimpson, Invertebrata of Grand Manan, 1853, p. 26, is probably only a large variety of this species.

The genus *Drepania*, created by Lafont in Journ. de Conchyl., xiv, 1874, p. 369, for *D. fusca* found at Arcachon, is nearly allied to *Ancula*, but has (*a*) only a single appendage on each rhinophore; (*b*) a single papilla near the branchiæ; (*c*) two small labial plates; (*d*) no outer teeth in the radula, so that the formula is simply 1.0.1.]

Genus 3. **Idalia** Leuckart.

See F. S. Leuckart, Breves animalium quorundam . . . Descriptiones, 1828, p. 15; Bergh **22**, pp. 140—181.

Body high, foot broad, and prolonged into a tail; dorsal surface small. Pallial margin prominent and bearing a row of more or less elongate papillæ all round. Over the mouth an oral veil produced on either side into an indistinct tentacular expansion. Rhinophores perfoliate, not retractile. Branchiæ simply pinnate, usually rather numerous (ten to eighteen). Penis armed with hooks; prostate large. Buccal crop sessile. A small labial armature of hooks is present. Formula of radula 1 + 1 . 0 . 1 + 1. Inner teeth large, hamate, smooth or denticulate; outer small, flat, but generally with indications of a hook or spine.

The genus has been divided by Alder and Hancock, followed by Bergh, into two sections: (*a*) *Idalia sensu stricto* in which the centre of the dorsal surface bears papillæ, the labial armature is a ring, and the inner teeth are smooth or minutely denticulate; and (*b*) *Idaliella* Bergh, in which the centre of the back is smooth, the labial armature consists of two plates, the inner teeth are strongly denticulate, and the outer teeth hooked.

(Idalia sensu stricto.)

1. I. elegans Leuckart.
(*Pt.* 7, *Fam.* 1, *Pl.* 27.)

2. Idalia leachii A. & H.
(*Pt.* 7, *Fam.* 1, *Pl.* 27.)

(**Idaliella.**)

3. I. aspersa A. & H.
(*Pt.* 1, *Fam.* 1, *Pl.* 26.)

4. I. inæqualis FORBES.
Perhaps merely a variety of No. 3. See Garstang **1**, p. 186.

5. I. pulchella A. & H.
var. fusca ODHNER **1**, p. 101.

Idalia quadricornis (Montagu) can hardly be identified and had better be omitted from the list.

[FAMILY IV. **CORAMBIDÆ.**

See H. A. Adams on *Hypobranchiæa fusca* in Proc. Zool. Soc., 1847, p. 24; Verrill on *Doridella obscura*, in Amer. Journ. of Science, 1870, vol. 1, p. 408; Bergh on *Corambe sargassicola*, **5**, pp. 21—25; Kerbert on *Corambe batava*, in Tijdschrift der Nederlandsche Dierkundige Vereiniging, Dl. 1, Af. 2, pp. 5—6, 1886; H. Fischer, Recherches anatomiques sur un Mollusque Nudibranche appartenant au Genre *Corambe* (*C. testudinaria*), 1891, Bull. Sci. France et Belgique, xxiii, 1891; and Balch on *Corambella depressa*, in Proc. Boston Soc. Nat. Hist., vol. xxix, 1901, pp. 151—153.

It is not easy to say how many of the above genera are valid. *Hypobranchiæa* and *Doridella* are so imperfectly described that it is better to neglect them, at any rate provisionally, and make *Corambe* the type of the family, which is well defined in most points. The members of it are small (3—5 mm.), flat, elliptical, doridiform animals with retractile rhinophores, a compact liver, a labial armature (as a rule), and a narrow radula without a central tooth. But they differ from nearly all known Holohepatica in having the vent and branchiæ at the end of the body and under the pallial margin, the branchiæ consisting of a few lamellæ arranged on either side of the vent. The genital orifices are on the right side and only one spermatotheca has been found. Molluscs belonging to this family are recorded from the Zuider Zee, Arcachon, the Sargasso Sea, and the Atlantic coast of the United States. It is therefore probable that they are found in the British area, but have escaped notice on account of their minute size.

Corambe Bergh. Pallial margin notched at the posterior extremity above the branchiæ. A labial armature.

1. *C. testudinaria* Fischer, from Arcachon. Brownish. Radula 4 + 1.0.1 + 4. First lateral large and denticulate; the rest much smaller.

Corambella Balch, from the Atlantic coast of North America, is said to have the mantle-edge even all round and not notched, and also to have no labial armature.

1. *Clla. depressa* Balch. Brownish with reticulate markings. Radula 5+1.0.1+5; first lateral smooth.]

B. CLADOHEPATICA.

The liver does not form a single mass but is divided, and in the majority of families ramified. In the first nine families given below the radula is not ascoglossan, and jaws are invariably present.

Family I. **PLEUROPHYLLIDIIDÆ.**

See especially Bergh **4**, which is a monograph on the family.

A very distinct family which has apparently been specially modified for a burrowing life. Animals of a fair size, flat, oval or tongue-shaped, and of leathery consistency. Head with a tentacular shield behind which is a sort of neck bearing retractile rhinophores. No dorsal appendages. The margin of the mantle usually bears cnidopores, and underneath it are usually branchial lamellæ. Radula broad, jaws strong, liver ramified.

Genus 1. **Pleurophyllidia** Meckel.

Cnidocysts and branchial lamellæ are present. The anterior pallial margin forms a continuous fold behind the rhinophores, and in front of them there is usually a special prominence known as the caruncle.

1. Pl. lovéni Bergh.
(*Pt.* 8, *Pl. VIII, figs.* 8—10.)

See Bergh **15**.

No other species is recorded with certainty from the northern Atlantic. The occurrence there of the Mediterranean species *P. undulata* (= *lineata*) is doubtful though not improbable. *P. müller*i is known from Brazil, and several species are reported from South Africa. *Pleuroleura* (= *Dermatobranchus*) *walteri* Krause is recorded from Spitzbergen. This genus resembles *Pleurophyllidia* in most points but has no lamellæ beneath the mantle-margin nor branchiæ of any kind.

Family II. **DENDRONOTIDÆ.**

Limaciform animals with oral veils and dorsal appendages which are usually branched and sometimes arborescent. Rhinophores retractile into projecting sheaths. Radula moderately wide or narrow. Liver divided into three portions, which commonly, but not invariably, send branches to the dorsal appendages.

Genus 1. **Dendronotus** A. & H.

See Bergh **18**, pp. 136—144; **24**, pp. 25—33; Herdman and Clubb, Second Report on Nudib. of L. M. B. C. District, Trans. Liverpool Biol. Soc., vol. iii, p. 225; Clubb, in ditto, vol. ix, 1895, pp. 220—234.

Animals of large or moderate size. The oral veil and rhinophore sheaths bear arborescent processes. Rhinophores perfoliate. On either side of the back a single row of arborescent cerata. Radula varying from about 6.1.6 to 21.1.21. Liver consisting of a large posterior mass and two smaller anterior portions.

The hepatic diverticula extend into the cerata in some cases, but not in others. The genitalia are unarmed. The hermaphrodite gland is large, and lies above the posterior liver. Prostate present.

1. D. frondosus (Ascanius).
(*Pt.* 1, *Fam.* 3, *Pl.* 3.)

2. D. lacteus (Thompson).

Thompson, Ann. Nat. Hist., v. 5, 1840, p. 88; Becher, Moll. von Jan Mayen, 1886, p. 14.

[3. D. robustus Verrill, 1870.
= D. velifer G. O. Sars, 1878.

See Verrill, Amer. Journ., i, 1870, p. 405; *id.*, Proc. U. S. Nat. Mus., ii, 1879, pp. 197—198; *id.*, Catalogue of Marine Molluscs added to Fauna of New England, Trans. Connect. Acad., v, 2 1882, p. 550; G. O. Sars **1**, pp. 315—316; Bergh **50**, pp. 141—144.]

It seems a pity that a name so familiar to British marine zoologists as *Dendronotus arborescens* should be altered. It rests on the authority of O. F. Müller, who described *Doris arborescens* in 1776. But there can be little doubt that this animal is the same as the *Amphitrite frondosa* described by Ascanius in K. Norske Vidensk. Selskabs Skrifter., Deel v, p. 155, pl. v, fig. 2, 1774, and this specific name has priority.[1]

D. luteolus Lafont in Actes Soc. Linn. Bordeaux, tom. xxviii, 1871, p. 267, is probably a variety of this species. Becher considers *D. lacteus* to be separate, since it differs in dentition as well as coloration.

D. robustus is recorded from both sides of the northern Atlantic, but not as yet from British waters. It is as much as 90 mm. long, and red with white dots. The oral veil is very large with numerous short processes which bear knobs but are hardly branched. The rhinophore sheaths bear five almost simple processes. There are seven pairs of cerata, lower and smaller than in *D. frondosus*, with a small appendage on the outside near the base. Jaws rather shorter and broader than in *D. frondosus*. Radula from about 30 × 15.1.15 to 35 × 20.1.20. Median teeth with prominent central cusp and fifteen to twenty side denticles. Lateral teeth with very irregular denticulation.

[1] It is used in the list of Plymouth Marine Invertebrate Fauna, published in the J.B.M.A., 1904. It is a blessing that no one proposes to substitute *Amphitrite* for *Dendronotus*.

[The genus *Campaspe* Bergh (**2** and **24**, pp. 20—24), represented by two small species from the northern Atlantic, seems to be a section of *Dendronotus* rather than a separate genus. It is defined as having the cerata and the processes of the rhinophores and of the frontal veil simpler and less branched, characters which also appear in *D. robustus*.

1. *C. pusilla* Bergh, a minute ($3\frac{3}{4}$ mm.) form with five to six simple papillæ on the veil and four simple digits on the rhinophore sheaths. Four pairs of short stout cerata. Radula thirty-five rows, each consisting of a central tooth with seven denticles on its side and from three to five lateral teeth bearing four to five denticles.

2. *C. major* Bergh is larger (12 mm.), and as preserved, white with red spots. The veil with four shortly branched processes. The six pairs of cerata are similar to those processes but taller. Radula 47 × 9.1.9. The median tooth as in *D. frondosus*. Most of the laterals bear six to seven denticles. The innermost are smaller than the rest, and the outermost are almost smooth.]

Family III. **LOMANOTIDÆ.**

Most of the characters are as in the Dendronotidæ, but the appendages are not ramified. The mantle-margin bears cerata which are simple (rarely lobed) and often carried horizontally. They are usually united by an undulating membrane. *Hancockia* is perhaps most conveniently placed in this family, but is really intermediate between the Lomanotidæ and Dendronotidæ.

Genus 1. **Lomanotus** Vérany.

See Bergh **11**, pp. 4—9; Vayssière **2**, pp. 87—91; Eliot **1**, pp. 348—353; Coghlan in Ann. Mag. Nat. Hist., ser. 8, vol. ii, 1908, pp. 205—218.

A frontal veil with a few digits. Corners of foot produced. Rhinophores perfoliate and provided with sheaths. The dorsal margin bears a series of papillæ of various sizes which often seem to be united into an undulating curtain. Radula fairly long and broad (maximum about 32 × 35.1.35), teeth denticulate on both sides and somewhat irregularly arranged so that it is not clear if there is a central tooth or not. Liver system apparently in three parts, one posterior and two lateral. The diverticula seem to extend into the cerata in some specimens but not in all. Genitalia unarmed.

I have discussed the synonymy of this difficult genus above, pp. 112—114. Perhaps three species may be provisionally recognized:

1. L. genei Vérany.
   (*Pt.* 8, *Pl. III, figs.* 1—8.)
   = L. portlandicus Thompson.
   L. hancocki Norman.
   L. eisigii Trinchese.

2. Lomanotus marmoratus A. & H.
(*Pt.* 3, *Fam.* 3, *Pl.* 7 *a.*)
3. L. flavidus A. & H.
(*Pt.* 6, *Fam.* 3, *Pl.* 41.)

But it is possible that the last two species will prove to be young forms of the first. The only recorded exotic species is *L. vermiformis* Eliot from the Red Sea. This, too, may be a young form and have been introduced into the Red Sea from the Mediterranean through the Suez canal.

Genus 2. **Hancockia** Gosse, 1877.

= Govia Trinchese, 1886.

See Gosse in Ann. Mag. Nat. Hist., ser. 4, xx, 1877, pp. 316—319; Gamble, On Two Rare British Nudibranchs, *ib.*, ser. 6, vol. ix, 1872, pp. 378—385; Trinchese, Ricerche anatom. sul genere *Govia*, in Mem. della R. accad. delle Sci. dell'istituto di Bologna, ser. 5, vol. vii, 1886, pp. 183—191.

Animal elongate. Foot truncate in front. Head with an oral veil bearing digits at the sides. The rhinophores bear a few perfoliations and are set in long sheaths. On the dorsal margin are about five lobed processes. Jaws denticulate. Radula triseriate and much like that of *Galvina*. Liver in three divisions (two entering the stomach laterally and one posteriorly) which give off diverticula to the cerata. Cnidocysts appear to be present. Genitalia unarmed. The hermaphrodite gland, which is formed of many globules, fills the posterior part of the body-cavity.

1. H. eudactylota Gosse.

Family IV. **SCYLLÆIDÆ.**

On either side of the back are two papillæ or a single lateral wing bearing branchial tufts. The radula is rather wide; the second stomach is armed with plates; the hermaphrodite gland consists of a few distinct masses.

Genus 1. **Scyllæa** L.

This semipelagic genus, which lives on floating seaweed, is said to be wafted occasionally to our shores. The animals are of singular shape. The foot is narrow; the body is compressed laterally and bears two large rhinophore sheaths, and on either side of the back two large papillæ. The inner sides of these papillæ, as well as the crest which runs along the top of the tail, bear branchial tufts.

1. Sc. pelagica L.

Family V. **HEROIDÆ.**

Æolidiform animals with branched cerata, one pair of which is set in front of the rhinophores. Radula triseriate. Liver in two longitudinal canals sending branches to cerata.

Genus 1. **Hero** Lovén.

See Bergh **32**, pp. 309—314; Eliot **2**, pp. 239—241; Vayssière **1**, pp. 88—92.

Foot rounded in front. Tentacles large, flat, and curved backwards. The cerata are branched (the principle of division being dichotomous), and the first pair are in front of the rhinophores. Jaws denticulate. Radula triseriate much as in *Galvina*. Genitalia unarmed.

The rhinophores have no sheaths and appear to be smooth in life, but when preserved they contract and become ringed or wrinkled.

1. H. formosa Lovén.
   var. arborescens Eliot.
   (*Pt.* 8, *Pl. IV, figs.* 1—4.)

Family VI. **JANIDÆ.**

Æolidiform animals in which the cerata extend in front of the rhinophores. Anus dorsal. A crest often present between rhinophores. Radula wide.

Genus 1. **Antiopella** Hoyle.

For anatomy, etc., see Bergh **6**, pp. 597—605; Trinchese **1**, pl. 44—48; Vayssière **1**, pp. 29—32.

Vérany described this genus as *Janus* in 1844, and this is the name used by Bergh, Trinchese, and Vayssière as being prior to *Antiopa*, the name used by Alder and Hancock in 1855. But, as Alder and Hancock point out in the text for Pl. 43, *Janus* has been in use for a genus of Hymenoptera since 1835, and is therefore invalid. But Hoyle states (Journal of Conchology, 1902, p. 214) that *Antiopa* is in its turn invalid for a similar reason, as it was used for a genus of Diptera in 1810. He proposes to call the animal *Antiopella*, and it would seem that this name must stand.

Flattish æolidiform animals, with cerata set round the dorsal margin, extending in front of the rhinophores and leaving the central space bare. No cnidocysts. Short oral tentacles. Rhinophores perfoliate with a crest between them. Anus in the medio-dorsal line but far back. Jaws strong, denticulate. Radula from 18.1.18 to 40.1.40. Liver-system composed of three main trunks which are ramified in the integuments, and also

send off diverticula to the cerata set round the dorsal margin and in front of the rhinophores. Genitalia unarmed.

1. Antiopella cristata (Delle Chiaje).
(*Pt.* 6, *Fam.* 3, *Pl.* 44.)

Genus 2. **Janolus** Bergh.

Bergh **23**, pp. 18—23; **47**, pp. 7—11: Eliot **1**, pp. 374—376.

Characters as in *Antiopella*, but the jaws are remarkably large and not denticulate.[1] The margin of the foot is often very broad.

1. J. hyalinus A. & H.
(*Pt.* 8, *Pl. V, figs.* 4—7.)
2. J. flagellatus Eliot.

See Eliot, *l. c.*

An uncertain species, known only from one alcoholic specimen. Cerata very small, but the larger may have been lost. Verge long and also provided with a long flagelliform appendage. Radula about 20.1.20; teeth not denticulate.

Genus 3. **Proctonotus** A. & H.

Rhinophores not perfoliate; no rhinophorial crest. Edge of jaws denticulate.

1. Pr. mucroniferus A. & H.
(*Pt.* 2, *Fam.* 3, *Pl.* 42.)

See Farran **1**, p. 9, for distribution and some other information.

Family VII. **FIONIDÆ.**

Æolidiform animals in which the cerata bear a branchial membrane. Male and female orifices some distance apart. A rudimentary mantle-margin present. Radula uniseriate. Liver in two longitudinal canals, which send branches to cerata.

[1] It may be doubted if *Janolus* is really generically distinct from *Antiopella*. The difference in the jaws is the only constant generic character, and the species differ from one another in many respects. Thus *J. hyalinus* comes very near to *Proctonotus*. If the distinction between *Antiopella* and *Janolus* were abolished the whole genus would be called *Janolus*, that name being prior to *Antiopella*.

Genus 1. **Fiona** Alder & Hancock.

See Bergh **1**; **18**, pp. 141—144; **49**, pp. 6—8.

The general shape is æolidiform, but the dorsal margin forms a rudimentary flap. Foot rounded in front. Oral tentacles set far back; rhinophores smooth. Cerata numerous, not arranged in rows, and each furnished with a lateral gill-membrane. Anus dextro-dorsal. No cnidocysts. Jaws denticulate. Radula uniseriate; teeth horse-shoe shaped.

1. Fiona marina (Forskål).
   = F. nobilis Hancock & Embleton.
   = F. atlantica Bergh.
   (*Pt.* 7, *Fam.* 3, *Pl.* 38 *a.*)

The above, which appears to be the correct specific name, is based on the identification of the animal with the *Limax marinus* of Forskål.

Family VIII. **DOTONIDÆ.**

Small animals agreeing with the Æolididæ in most points except that the rhinophores are protected by projecting sheaths. The cerata are stout and tuberculate.

Genus 1. **Doto** Oken.

See Bergh **11**, pp. 24—30; **14**, pp. 695—698; Vayssière **2**, pp. 99—106; Eliot, **1**, pp. 356—357.

Rhinophores smooth (except in *D. crassicornis*) with large cup-like sheaths. Cerata arranged in a single row on either side of the back; clavate and studded with papillæ or knobs. An oral veil over the mouth with short tentacular prolongations. Jaws smooth. Radula a long row of small horse-shoe shaped teeth, bearing a few denticles or ridges. In *Doto* the radula is uniseriate, but in the allied *Dotilla* there are four to five minute lateral teeth. Genitalia not armed. In the doubtful *Gellina affinis* (see *Tergipes affinis* in D'Orbigny, Nudibranches des Côtes de France, Mgz. de Zool., vii, 1837, pp. 4—5) recorded from Rochelle the cerata are said to be simple and smooth.

A great number of species have been described, but the genus requires revision based on the study of a large series of living animals. The anatomical characters offer hardly any points of difference, and the external features, such as the coloration and shape of the rhinophore sheaths, are very variable.

1. D. coronata (Gmelin).
   (*Pt.* 2, *Fam.* 3, *Pl.* 6.)
   Probably = Hesse's *D. armoricana*, *D. confluens*, and *D. pinnigera*.

2. Doto fragilis (Forbes).
(*Pt.* 5, *Fam.* 3, *Pl.* 5.)
Possibly = *D. antarctica* Eliot.
3. D. pinnatifida (Montagu).
(*Pt.* 7, *Fam.* 3, *Pl.* 45.)
Probably = *D. splendida* Trinch. and *D. onusta* Hesse.
4. D. cuspidata A. & H., 1862.
(*Pt.* 8, *Pl. V*, figs. 1—3.)
5. D. cinerea Trinchese.
[6. D. crassicornis M. Sars.
Norway. M. Sars, Om Christianiafjordens Fauna, in Nyt Mag. fur Naturvidenskabene, Christiania, 1870, p. 193.

Luteo-fusca; velo semilunari; tentaculis cylindro-conicis, *crassis, transverse sulcatis*, e vaginis brevibus, tubæformibus, margine sinuato aut crenulato, haud expanso, prodeuntibus; branchiis utrinque 6, ovato-conicis, crassis, non pedicellatis, papillis luteo-albidis immaculatis, in circulis 3 transversis dispositis. Habitat in freto *Dröbachiensi*: 50—60 fathoms. Length 5—6 mm.

Sars' plate xii, figs. 1—6, represents an animal with small low cerata and thick rhinophores bearing circular lamellations. It is stouter than most species of *Doto*. The characters, if established, seem to constitute a valid species.]

Family IX. ÆOLIDIDÆ.

Limaciform animals bearing unbranched cerata on the dorsal surface. The liver is represented by the diverticula which these cerata contain, and does not, as in *Dendronotidæ*, etc., form masses in the body-cavity. Rhinophores simple or perfoliate, but never with sheaths. Radula uniseriate or triseriate. Cnidocysts usually present.

a. TRISERIATÆ.

Each transverse row of the radula contains three teeth.

[*Gonieolis* M. Sars and *Chlamylla* Bergh are two genera comprising four species, mostly known by single specimens. Odhner maintains that the true *Gonieolis* of M. Sars is not an Æolid and has no hepatic diverticula in the cerata. He considers that *Chlamylla* should be made to include *Gonieolis* Bergh, which is not the same as *Gonieolis* M. Sars. The genus *Chlamylla* thus constituted is allied to *Coryphella* and *Cumanotus*. The animals are rather large, with head shields and projecting dorsal margins, large rhinophores and tentacles and numerous cerata which are often small. They were all found in the North Atlantic and may occur in the British area. An examination of further specimens seems desirable before the place of these forms is fixed. See Bergh **24** and **54**; Odhner **1**.]

Genus 1. **Coryphella** Gray.

Bergh **7**, pp. 635—640; *id.*, **11**, pp. 563—565; *id.*, **13**, pp. 51—54; and many other places; Vayssière **2**, pp. 563—565; Eliot **1**, pp. 358—361.

Form elongate and slender; corners of foot produced; rhinophores not perfoliate but often wrinkled; jaws with several rows of denticles.

1. C. rufibranchialis (Johnston).
   (*Pt.* 4, *Fam.* 3, *Pl.* 14.)
2. C. gracilis (A. & H.).
   (*Pt.* 6, *Fam.* 3, *Pl.* 18.)

C. smaragdina A. & H. appears to be merely a green variety of this species. Forms intermediate in colour are found. See also Farran **2**, p. 7.

3. C. pellucida (A. & H.).
   (*Pt.* 3, *Fam.* 3, *Pl.* 19.)
4. C. landsburghii (A. & H.).
   (*Pt.* 4, *Fam.* 3, *Pl.* 20.)
5. C. salmonacea (Couth.).

[6. C. verrucosa (M. Sars).

M. Sars, Bidrag til Södyrenes; Friele and Hansen **1**, p. 7; Naturhist., 1829, p. 9.

Briefly described by Sars as "*Eolidia verrucosa*, corpore oblongo, supra branchiis numerosis (100—150) erectis, cylindricis, obtusis, ferrugineis, apicibus albis." Cerata very short. The central tooth has 5 denticles on either side of a small median cusp; the laterals are slender and bear 5—6 denticles.]

7. C. lineata (Lovén).
   probably = C. argenteolineata (Costa).
   (*Pt.* 5, *Fam.* 3, *Pl.* 16.)

Farran **2**, p. 7.

[8. C. sarsi Friele.

Friele **2**, p. 12.

Length 16 mm. Described from a single preserved specimen and chiefly characterized by shape of foot, which is rounded posteriorly. Head and oral tentacles large. Rhinophores smaller and wrinkled. Cerata thickly set. Radula 20 rows. Central tooth with small denticles on either side of median cusp. Lateral teeth with 8—9 small denticles.]

[9. C. stimpsoni Verrill.

See Krause, Mollusk. v. Ostspitzbergen, in Zool. Jahrb. System. Geog. u. Biologie 6, 1892, pp.

369—371, and Knipowitsch in Annuaire du Musée Zool. St. Pétersbourg, vii, 1902, pp. 390—391. Bergh **13**, pp. 54—6.

Recorded from north Norway and Arctic seas, but also from Massachusetts. Distinguished chiefly by its radula. Median teeth with 6—9 denticles: laterals small and smooth.]

Genus 2. **Cumanotus** Odhner.

Odhner **1**, pp. 29, 80, and 101—102; Eliot **3**, pp. 313—314.

Most of the external characters of the genus and the buccal parts are as in *Coryphella*, but (1) the oral tentacles are very small, and are merely points on a continuous oral veil which connects them; (2) there are several (at least three) rows of cerata in front of the rhinophores; (3) the verge is deeply grooved, and there is a bursa copulatrix bearing at its entrance two circular pads armed with cones terminating in hooks.

1. C. beaumonti Eliot.
   (*Pt.* 8, *Pl. VIII, figs.* 1, 2.)

[2. C. laticeps Odhner.]

These two species are possibly identical.

Genus 3. **Galvina** A. & H.

Foot rounded in front. Cerata somewhat inflated. Radula rather long and in some species tapering. Central tooth denticulate with the apex rather depressed; lateral teeth broad, not denticulate. Jaw with a row of coarse denticles. The genus *Capellinia* Trinchese, which has a triseriate radula like that of *Galvina*, but cerata studded with knobs or tubercles, should probably be united with *Galvina*.

1. G. exigua A. & H.
   (*Pt.* 5, *Fam.* 3, *Pl.* 37.)
2. G. tricolor (Forbes).
   (*Pt.* 1, *Fam.* 3, *Pl.* 34.)
3. G. farrani A. & H.
   (*Pt.* 1, *Fam.* 3, *Pl.* 35.)
   Probably = *Eolis adelaidæ*, *Eolis andreopolis*, and *Eolis robertianæ*.
4. G. amethystina A. & H.

These species are nearly related, and should possibly all be regarded as varieties of *G. tricolor*.

5. G. vittata A. & H.
   (*Pt.* 6, *Fam.* 3, *Pl.* 29.)
6. G. picta A. & H.
   (*Pt.* 3, *Fam.* 3, *Pl.* 33.)

This species was originally called *G. pallida*, and A. & H. themselves

arbitrarily changed the name. But perhaps it is better (though irregular) to keep the name *picta*, under which it has been described by Bergh and Trinchesse.

7. G. ?cingulata A. & H.
(*Pt.* 3, *Fam.* 3, *Pl.* 28.)

We have no definite statement as to the radula of this species, but Alder (**1**) classes it with *G. tricolor*.

[8. G. fustifera (Lovén).
Lovén **1**, p. 7.

North Atlantic. "Branchiis in fasciculos utrinque 6—7 digestis, validis, elongatis tuberculosis. Pellucido alba, fusco maculata, vasibus fuscis. 8 mm." Probably a *Galvina* or *Capellinia*, but the teeth are unknown.

9. G. flavescens Friele & Hansen.
Friele and Hansen **1**, p. 78.

North Atlantic. White or light yellow. Cerata long, with yellow liver branches; tips white. Radula 35 rows; median cusp of central tooth deflexed with 5 denticles on either side.

10. G. rupium Möller.
Bergh **3**, p. 80.

Recorded from Greenland. "Corpore luteo, papillis dorsalibus 6 in utroque latere luteis, apice albo, basi annulo fulvo cinctis." Radula 34—37. The plates depict the teeth as having no median cusp, but only 5—6 lateral denticles.]

β. UNISERIATÆ.

The radula consists of a single longitudinal row of teeth.

Genus 1. **Tergipes** Cuv.

Bergh **11**, pp. 569—572.

Rhinophores simple. Oral tentacles distinct. A single row of inflated cerata on either side. Foot rounded in front. Jaws with a single row of denticles. Radula fairly long and tapering.

1. T. despectus (Johnston).
(*Pt.* 1, *Fam.* 3, *Pl.* 36.)

[2. T. claviger (Menke).
Menke in Zeitschr. für Malakoz., 1844, p. 149.

North Atlantic. "Corpore ovato-oblongo, posterius attenuato; albidus; branchiis dorsalibus utrinque 9, clavatis, erectis, subpellucidis, tentaculis cylindrico-filiformibus."

3. T. ? bullifer Lovén.

Lovén, Index Mollusc., 1846, p. 7.

"Velo utrinque papillam brevem formante, branchiis inflatis, bullaceis, uniseriatis. Alba, fusco varia. 7 mm."]

Genus 2. **Embletonia** Alder & Hancock.

Bergh **13**, pp. 33—39.

Much like *Tergipes*, but head rather broad with rounded lappets and no oral tentacles. Cerata few, subclavate; jaws smooth or denticulate.

1. E. pulchra A. & H.
(*Pt.* 5, *Fam.* 3, *Pl.* 38.)
2. E. minuta (Forbes & Goodsir).

See Athenæum of 31 August, 1839, and Alder **1**, p. 36. Probably a variety of *E. pulchra*. Rhinophores longish, wrinkled. Cerata nearly linear; pinkish; tipped with white; 7 on each side in single series.

3. E. pallida A. & H.
(*Pt.* 8, *Pl. VI, figs.* 1, 2.)

E. grayi Kent (Proc. Zool. Soc., 1869, pp. 109—111) is probably a variety of this species, as may be also *E. fuscata*, *E. lanceolata*, and *E. remigata*, all from the Atlantic Coast of North America and described by Gould **1**, pp. 251—252.

Genus 3. **Facelina** Alder & Hancock.

Bergh **7**, pp. 399—409; **9**, pp. 752—758; **10**, pp. 824—829; **12**, pp. 24—37; **13**, pp. 41—48; Vayssière **1**, pp. 33—50; Trinchese **1**, pp. 31—36.

Trinchese's genus *Acanthopsole*, which is characterized by having the rhinophores annulate rather than perfoliate, seems to be merely a section of *Facelina*.

Body elongate. Cerata set in groups. Corners of foot produced into long processes. Oral tentacles long. Rhinophores perfoliate or annulate. Jaws and teeth both strongly denticulate. Glans penis foliaceous and armed with spines.

1. F. drummondi (Thompson).
(*Pt.* 4, *Fam.* 3, *Pl.* 13.)

Probably = *F. gigas* (Costa), *F. quatrefagesi* Vayss., *F. panizzæ* (Verany), and *F. janii* (Verany).

2. Facelina coronata (Forbes).
(*Pt.* 2, *Fam.* 3, *Pl.* 12.)
3. F. punctata A. & H.
(*Pt.* 2, *Fam.* 3, *Pl.* 15.)
[4. F. auriculata (O. F. Müller).

Recorded from Norway. See Friele and Hansen **1**, pp. 74—75. Body white; cerata red with white tips; tentacles and rhinophores very long. Cerata in 4 clusters. Radula, 14 teeth with strong median cusp and 7 lateral denticles.

Genus 4. **Favorinus** Gray.

Bergh **8**, pp. 640—643; **10**, pp. 822—823; **11**, pp. 565—568; **12**, pp. 49—53; **13**, pp. 39—40. Trinchese **1**, pp. 67—74. Vayssière **1**, pp. 75—81.

Body elongate. Oral tentacles long; corners of foot produced into long processes. Rhinophores not perfoliate but with a bulbous swelling below the tip. Cerata in clusters. Jaws with long denticles. Teeth smooth or bearing very inconspicuous denticles.[1]

1. F. albus A. & H.
(*Pt.* 1, *Fam.* 3, *Pl.* 21.)
2. F. ? carneus A. & H.

See also Eliot **4**, pp. 158—159.

A doubtful species. If it is really the animal described by me from the Cape Verde Islands it has *two* bulbs below the tip of the rhinophores.

[3. *F. branchialis* (Müller), recorded from Norway, does not seem to differ from *F. albus* in any marked character, but the denticulation of the teeth is more distinct. See Bergh **11**, pp. 566—568.]

Genus 5. **Amphorina** Quatrefages.

See, for the characters and limits of the genus, Eliot **1**, p. 364; see also Bergh **12** and **13**.

Cerata somewhat inflated. Jaws with a row of minutes denticles. Radula long (50—80) and tapering. The denticles, especially the median cusp, arise far back and hence appear elevated. Penis armed with a spine.

1. A. cœrulea (Montagu).
Probably = A. molios Herdman.
(*Pt.* 8, *Pl. VI, figs.* 6—8).

[1] The statements of different observers as to the teeth differ. The lateral denticles appear not to be strongly developed in any species, and in most they are reduced to mere striations which sometimes disappear, leaving a smooth spine.

2. Amphorina aurantiaca (A. & H.).
= Cuthona aurantiaca.
(*Pt.* 5, *Fam.* 3, *Pl.* 27.)

Beaumont **1**, pp. 836, 837. Eliot **1**, p. 367.

3. A. olivacea (A. & H.).
= Cratena olivacea.
(*Pt.* 1, *Fam.* 3, *Pl.* 26.)

Beaumont **1**, p. 834. Eliot **1**, p. 368.

4. A. viridis (Forbes).
(*Pt.* 6, *Fam.* 3, *Pl.* 32.)

Apparently an *Amphorina*, but further examination is desirable.

5. A. glottensis (A. & H.).
(*Pt.* 6, *Fam.* 3, *Pl.* 29.)

Farran **2**, p. 6. Radula 55, tapering; central cusp retreating; 6 lateral denticles. Penis armed with small flattened spine.

Genus 6. **Cuthona** A. & H.

(= **Cuthona** A. & H. + **Cratena** Bergh.)

Eliot **1**, pp. 363—365.

Foot rounded in front. Rhinophores not perfoliate. Cerata fairly numerous. Radula usually short and not markedly tapering, with a few (rarely more than ten) denticles on either side of the central cusp. No armature on the genitalia as a rule.

1. C. nana A. & H.
(*Pt.* 4, *Fam.* 3, *Pl.* 25.)
2. C. peachii A. & H.
(*Pt.* 6, *Fam.* 3, *Pl.* 10.)
3. C. stipata A. & H.
(*Pt.* 6, *Fam.* 3, *Pl.* 22.)
4. C. concinna A. & H.
(*Pt.* 1, *Fam.* 3, *Pl.* 24.)
5. C. pustulata A. & H.
(*Pt.* 7, *Fam.* 3, *Pl.* 45.)
6. C. amœna (A. & H.).
(*Pt.* 2, *Fam.* 3, *Pl.* 30.)
7. C. ? inornata (A. & H.).
(*Pt.* 8, *Pl. VI, fig.* 3.)
8. C. ? northumbria (A. & H.).
(*Pt.* 3, *Fam.* 3, *Pl.* 31; and *Pt.* 8, *Pl. VI, figs.* 4, 5.)

[9. C. longicauda Heincke.

See Heincke, Nachtrage zur Fisch- und Mollusken fauna Helgolands in Wissenschaftl. Meeres Untersuch., N.F., Bd. ii, 1897, pp. 251—2.

Tail very long. Cerata long, set in 9 groups. Body yellowish white; cerata olive with white tips. Radula uniseriate; 20 teeth; median cusp short; 6—7 lateral denticles.

[*Hervia* Bergh **7** is distinguished from *Cuthona* merely by having the front of the foot not rounded but with the corners produced into horn-like processes. This does not seem sufficient as a generic character, and *Hervia* should probably be reckoned as only a sub-genus. On the other hand it might be equally well described as a *Coryphella* with a uniseriate radula. One species, *H. modesta*, is recorded from the north Atlantic (Kattegat). The colour in life is unknown, in alcohol brownish. The cerata are set in seven groups. The radula consists of twenty-one teeth, with a strongish central cusp and twelve to fourteen lateral denticles.]

Genus 7. **Æolidiella** Bergh.

Bergh **12**, pp. 7—12; **13**, pp. 22—26; Vayssière **1**, pp. 107—111.

Body somewhat elongate and depressed. Cerata somewhat flattened. Corners of foot produced into short processes. Rhinophores not perfoliate but sometimes transversely wrinkled or furrowed. Jaws not denticulate. Teeth pectiniform, but divided into two halves, and with a more or less developed median denticle. Ptyaline glands present.

1. Æ^lla. glauca (A. & H.).
   (*Pt.* 4, *Fam.* 3, *Pl.* 11.)
2. Æ^lla. alderi (Cocks).
   (*Pt.* 6, *Fam.* 3, *Pl.* 10.)
3. Æ^lla. angulata A. & H.
   (*Pt.* 2, *Fam.* 3, *Pl.* 23.)

See the description of this species, pp. 131—132.

4. Æ^lla. sanguinea (Norman).

Norman, in Ann. Mag. Nat. Hist., 1877, On Two New British Nudibranchs.

"Our new form comes nearest to *E. glauca*, from which it differs in its more attenuated form, in its more numerous transverse rows of branchiæ and more numerous branchiæ in those rows, in its more brilliant body-colour and in its branchiæ being blood-red instead of sage-green." The dentition is unknown.

One may doubt if these species are really distinct from one another or from *Æolidiella sœmmeringii* found in the Mediterranean.

Spurilla Bergh, which differs from *Æolidiella* only in having the rhinophores perfoliate, and *Berghia* Trinchese, in which they are perfoliate and also bear small knobs, should probably be regarded as sub-genera of *Æolidiella*. In *Æolidiella* the rhinophores are a little wrinkled, and it does not seem as if the greater development of these wrinkles should constitute a generic difference.

For the occurrence of *Berghia cœrulescens* in British waters see Eliot **1**, p. 357.

The specimen preserved at Plymouth under this name is really a *Facelina coronata*, but Professor Garstang tells me that he believes the species does occur at Plymouth. There is no reason why it should not, for it is reported to be plentiful at Arcachon and even at St. Malo. See Cuénot **2**, pp. 8—9.

Genus 8. **Æolidia** Cuv.

Bergh **6**, pp. 618—620; **7**, pp. 695—696; **10**, p. 822; **18**, pp. 130—133; **50**, p. 127; **51**, p. 451; Eliot, **5**, pp. 351—352.

Body stoutish, flattened. Corners of foot slightly produced. Rhinophores smooth. Cerata flattened. Anus dextro-dorsal. Jaws with smooth edges. Teeth simply pectinate without any median cusp or division into two halves.

1. Æ. papillosa L.
(*Pt.* 6, *Fam.* 3, *Pl.* 9.)

The three known species of *Æolidia*, namely this one, *Æ. serotina* (Chile and Falkland Islands), and *Æ. herculea* (California), show few decided differences and are perhaps merely varieties.

γ. SERRATÆ.

The radula is uniseriate, but the teeth are fused together so that it resembles a jagged thread.

The researches of Mr. Evans make it probable that this group ought to receive the rank of a separate family.

Genus 1. **Calma** A. & H.

Animal flattish. Cerata arranged in rows and sometimes arising from a pedestal. No cnidocysts. Rhinophores simple. Anterior corners of foot produced into prolongations. Genitalia unarmed. Jaws not denticulate. Radula a continuous band not divided into separate teeth, and merely bearing serrulations on the upper surface. Digestive system much simpler and less ramified than is usual in the Æolididæ. Renal organ also simple and not ramified. Hermaphrodite gland symmetrically arranged on the two sides of the body.[1]

1. C. glaucoides A. &. H.
(*Pt.* 6, *Fam.* 3, *Pl.* 22; and *Pt.* 8, *Pl. V, fig.* 8.)

[1] Since the above was written Mr. Evans has discovered that *C. glaucoides* has neither intestine nor anal opening, and that the male and female openings are separate as in *Fiona*. In view of these discoveries, the animal should probably be made the type of a separate family, but the information was received too late to make the necessary changes in the text of the present work.

The remaining families belong to the Cladohepatica Ascoglossa, which among other peculiarities have a special form of radula, no jaws, and no cnidosacs.

Family X. **HERMÆIDÆ.**

Æolidiform animals which can be distinguished externally from the Æolids only by (1) the absence of oral tentacles and the shape of the rhinophores, which are grooved or auriform, (2) the position of the anal papilla, which is dorsal and in front of the pericardium.

Genus 1. **Hermæa** Lovén.

See Bergh **10**, pp. 4—49; **13**, pp. 1—11; Trinchese **1**, and Anatomia della *Hermæa dendritica*, Bologna, 1877; Vayssière **2**, pp. 128—132.

The rhinophores are auriform. The cerata are elongate and each row contains several. There is no *ingluvies buccalis*. The teeth of the radula are usually quite smooth, and when worn out lie in an irregular heap. The hepatic system is composed mainly of two lateral canals; these send off diverticula which ramify within the cerata. The complicated genitalia comprise two spermatothecas and several ramified glands, some of which extend into the cerata. The verge is armed with a spine.[1]

[The following genera, which are recorded only from the Mediterranean, but probably occur elsewhere, are allied to *Hermæa*, and, as far as is known, resemble it in all points except those mentioned. They should perhaps be regarded as sub-genera. (1) *Hermæina:* The teeth are serrulated on the lower margin. (2) *Hermæopsis:* The anal papilla is lateral. (3) *Placida:* The hepatic diverticula within the cerata are simple and not branched.]

1. H. bifida (Montagu).
   (*Pt.* 5, *Fam.* 3, *Pl.* 39.)
2. H. dendritica A. & H.
   (*Pt.* 4, *Fam.* 3, *Pl.* 40.)

[Two less certain species have been described from neighbouring waters.

3. H. venosa Loven.

Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1844, no. 3, p. 50.

"Gracilis, branchiis styliformibus, in series 7—8 digestis ternis v. quaternis, vase gastrobr. (*sic*) crassiusculo, varicoso: vibraculis validis exacte auriformibus, apice attenuato, obtuso: soleâ, antice rotundato-dilatatâ: quadrilinearis, albida, niveo punctata, vasibus fuscis. Habitat inter algas, rarior."

4. H. polychroma Hesse.

Diag. de Nudibr. nouv. des côtes de Bretagne, Journ. de Conchyl., 3 Ser. xiii, 4, 1873, p. 346.

"Corpus prægracile, acuminatum, antice obtusum, cœrulescens, lineâ rubescente supra caudam ornatum, collum luteum, lineis 2 violaceis ad tentacula superna decurrentibus notatum. Tentacula superna elongata, fusiformia, infra fissa, apice acuta, cœrulea.

[1] As the anatomy of these small animals is extremely complicated and variable, it is not safe to assume that the structure described by Bergh for particular species is really common to a whole group.

Velum latum, lateraliter expansum, arcuatum, cœrulescens. Cirrhi branchiales, utrinque in series 2 dispositi et 6—7 fasciculos formantes, fusiformes, validi, complanati, sanguinei, integri, apice luteo-aurantiaci, intus arborescentes. L. 20 mill. Rade de Brest."]

Genus 2. **Stiliger** Ehrenberg.

See Meyer and Möbius **1**, pp. 13—14; Bergh **28**, pp. 137—144; and **13**, pp. 12—17.

This genus resembles *Hermæa* in all important points of structure, but differs from it somewhat in appearance inasmuch as (1) the cerata are stout and swollen, much as in *Galvina*; (2) the rhinophores are smooth, simple, and not split or grooved. The oral tentacles are represented by two lumps.

Ercolania Trinchese is apparently only a sub-genus. It differs from *Stiliger* in having the rhinophores slightly grooved.

1. St. bellulus (d'Orbigny).
   = Calliopæa bellula (d'Orbigny).
   = Embletonia mariæ Meyer & Möbius.
   = Stiliger mariæ Bergh.

Genus 3. **Alderia** Allman.

Flattish animals with a general resemblance to Æolids. Head distinct and produced into a lobe on either side, but tentacles and rhinophores are both absent. Foot expanded and broader than the body, from which it is divided by a groove, so that the body, though narrower, partly overhangs it. On this projecting part of the body are set the cerata, two or three deep, somewhat inflated in shape, and containing ramified diverticula of the liver. Anal papilla prominent, medio-dorsal, and nearly terminal. Radula short. Teeth not denticulate; the disused teeth lie in an irregular heap. Verge armed with a spine.

1. A. modesta (Lovén).
   (*Pt.* 6, *Fam.* 3, *Pl.* 41; and *Pt.* 8, *Pl. VII, figs.* 3—6.)

[This is the only certain species. *A. harvardiensis* Agassiz is described and figured in Gould, **1**, pp. 254—255, pl. xvi, figs. 226—228. It is darker than *A. modesta*, has fewer and smaller cerata and a more angular head. But the figure and description do not altogether agree, and the form is probably a variety of our species. *A. comosa* Da Costa (Ann. del Museo. Zoologico, Napoli, 1864, p. 32) is green with numerous long cerata, and the anal papilla lies behind the pericardium.]

Family XI. **ELYSIIDÆ.**

Shape flat, almost leaf-like. The anterior margin of the foot produced into short processes. On either side is a broad, flexible, wing-like expansion, which is separated from the body by a distinct line. Behind the head lies the large pericardial prominence.

The back and wings are smooth and bear no cerata or appendages, but from the lower part of the pericardium proceed fine, raised, ramified lines (usually issuing from three main trunks) which mark the course of the blood-vessels. As a rule there is no *ingluvies buccalis*, and the teeth, which are shaped somewhat like daggers, are finely denticulate. The liver, the hermaphrodite gland, and accessory genital glands are all elaborately ramified within the wings, and do not form compact masses. The genitalia are not armed. Pelseneer states that the kidney communicates with the pericardium through many openings, but this is denied by some authorities.

Genus 1. **Elysia** Risso.

See Bergh **29**, pp. 175—190; Vayssière **1**, p. 137; Meyer and Möbius **1**, pp. 7—10.

Anus antero-dorsal. Rhinophores auriform. Wings not crinkled or united behind the head.

1. E. viridis Montagu.
   (*Pt.* 8, *Pl. VII, figs.* 1, 2.)

[2. E. minuta Sars.

See Bergh **29**, pp. 185—186, and references there given.

Coast of Norway. This very doubtful species was created by Sars in 1835, but in 1863 was recognized by him as not really distinct. Meyer and Möbius, Lovén, and Odhner (1907) regard it as merely a variety, but Bergh (*l. c.*) thinks it is a distinct species characterized by (1) its dark colour, (2) teeth with blunt tips.]

Family XII. **LIMAPONTIIDÆ.**

Minute slug-like animals without external gills, dorsal appendages, or pallial margin. Anus dorsal and posterior. Mouthparts as in Elysia; teeth not denticulate. Stomach small. Liver not much ramified, but divided into four main portions, two anterior and two posterior. Hermaphrodite gland consisting of diffuse follicles as in Elysia. Penis armed with a spine.

Genus 1. **Limapontia** Johnston, 1836.
=Pontolimax Creplin, 1848. Chalidis Quatrefages, 1844.

See Alder and Hancock **3**; Meyer and Möbius **1**, pp. 3—5; Bergh **30**, pp. 205—209.

The head bears two crest-like ridges but no rhinophores or tentacles.

1. L. nigra Johnston.[1]
   ? = L. capitata (O. F. Müller).
2. L. depressa A. & H.
   (*Pt.* 8, *Pl. VII, figs.* 6—8.)

[1] As A. & H. (**3**, p. 403) dispute the identity of *L. nigra* with *L. capitata*, it seems safer to retain the former name for the British species, though the latter has priority if the identity is accepted.

Genus 2. **Acteonia** Quatrefages.[1]

See Alder **1**, pp. 30—31; Alder and Hancock **3**, pp. 403—405.

Similar to *Limapontia*, but there is a slight ridge on either side of the back; the vent is not terminal but lies just behind the middle of the back, and the head bears two ridges, which are produced into short, flat, ear-like tentacular processes.

1. A. corrugata A. & H.

Genus 3. **Cenia** A. & H.

Originally called *Ictis*, but re-named by Alder and Hancock on finding that *Ictis* was already in use for a genus of Mammals.

See the same authorities as for *Acteonia*, and also Pelseneer, La condensation embryogénique chez un Nudibranche, in Trav. zool. Wimereux, tome vii, pp. 513—520.

Similar to *Acteonia* except that the head bears two long linear tentacles. Pelseneer has demonstrated that the larval development takes place entirely inside the egg and that the animal issues in the adult form.

1. Cenia cocksi A. & H.
(*Pt.* 8, *Pl. VII, figs.* 10—11.)

[1] It is doubtful if *Cenia* and *Acteonia* are really distinct. They are separated here merely because *Cenia* has been shown to have an unusual larval development, whereas the early stages of the dubious *Acteonia* are unknown.

BIBLIOGRAPHY.

The following bibliography is an attempt to give a list of the books and papers dealing with the Nudibranchiata of the Atlantic (including the Mediterranean and Caribbean seas) which have been published since the completion of Alder and Hancock's Monograph in 1855. Works dealing with the fauna of other seas are not included, unless they treat (as for instance do some papers on Californian Nudibranchs) of species which are also found in the Atlantic or are closely allied to Atlantic species. I have included the long series of descriptions published by the late Dr. R. Bergh under the title of Malacologische Untersuchungen, for though they are nominally concerned with the collection made by Semper in the Philippines, yet incidentally and sometimes in the most unexpected places, they deal with Nudibranchs from all the seas of the globe.

Part VII of the Monograph (pp. xxv—xxviii) contains a bibliography of about a hundred items published before 1855. I have not incorporated these in my list unless they seem to be of special importance, and those who are interested in early records of the British Fauna are referred to this earlier bibliography. But I have included all Alder and Hancock's own works, whatever the date, and also some early foreign works not mentioned in the Monograph.

The works which are frequently cited in other parts of the text are marked with a number, which is used in references. Thus Trinchese **1** means, not the first work by Trinchese on the list, but that work which has the figure **1** in front of it.

Abraham, P. S.

Revision of the Anthobranchiate Nudibranchiate Mollusca. Proc. Zool. Soc. 1877, pp. 196—269.

Abric, P.

Sur quelques variations expérimentales de coloration chez les Nudibranches. C.R. Soc. Biol. lvii, 1904, pp. 5—7.

Sur les nématoblastes et les nématocystes des Eolidiens. C.R. Soc. Biol. lvii, 1904, pp. 7—9.

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[1] It is extremely difficult to give exact references for Trinchese's numerous papers, as complete sets of some of the periodicals in which they appeared are not accessible in England. The titles given here are mostly taken from separate reprints in my possession, but such references as these reprints contain are often curiously vague, so that both the year and place of publication are sometimes matters of inference rather than certain knowledge.

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INDEX.

(*Rejected synonyms, and genera and species which are considered invalid, are in italics.*)

POSTSCRIPT.

While the last sheets of this work were going through the press, I received a letter from Mr. Nils Odhner informing me that he had been able to compare specimens of *Cumanotus beaumonti* from Plymouth and of *Cumanotus laticeps* from Norway, with the result that he regards the two species as identical.

ADLARD AND SON, IMPR., LONDON AND DORKING.

EXPLANATIONS OF THE PLATES.

PLATE I.

Figs.

1. *Adalaria lovéni.* (p. 108) Dorsal view of the whole animal. × 8.
2. Ditto. Ventral view of anterior portion.
3. *Aldisa zetlandica.* (p. 105) Dorsal view of the whole animal. × 4.
4. Ditto. A portion of the dorsal surface more highly magnified.

5 and 7. *Doris testudinaria.* (p. 99) Dorsal and ventral views of moderate-sized living specimen from Plymouth.

6. Ditto. Ventral view of large preserved specimen.
8. Ditto. Tubercles from the back. Enlarged.
9. Ditto. Teeth from radula. *a*—*c*, teeth from the inner part of the half row; *d*, tooth with an abnormal projection; *e*, tooth from near the end of the row; *f*, a deformed tooth from the end of the row.
10. *Tritonia alba.* (p. 93) Lateral teeth: *a*, second lateral; *b*, *c*, *d*, laterals from middle of half row; *e*, outermost tooth.

Figures 1—4, 6, and 8 are from drawings by Hancock. Figures 5 and 7 are from drawings of the living animal made at Plymouth, 1908.

1-2. ADALARIA LOVENI. 3-4. ALDISA ZETLANDICA. 5-9 DORIS TESTUDINARIA
10. TRITONIA ALBA.

PLATE II.

Figs.

1—3. *Crimora papillata*. (p. 110) Dorsal, lateral, and ventral views. × 5.

4. Ditto. One half of the oral veil showing appendages.

5. Ditto. Teeth: *a*, first lateral; *b*, second; *c*—*e*, third to seventh; *f*, eleventh; *g*, one of the outer teeth.

6 and 7. *Lamellidoris ulidiana*. (p. 108) Dorsal and lateral views. × 8.

8 and 9. *Lamellidoris luteocincta*. (p. 109) Dorsal and lateral views. × 8.

Figs. 1—4, 6, and 7 are from drawings by Hancock.

West, Newman chr.

1-5. CRIMORA PAPILLATA. 6-7. LAMELLIDORIS ULIDIANA.
8-9. LAMELLIDORIS LUTEOCINCTA.

PLATE III.

Lomanotus genei. (p. 115)

= *L. portlandicus.*

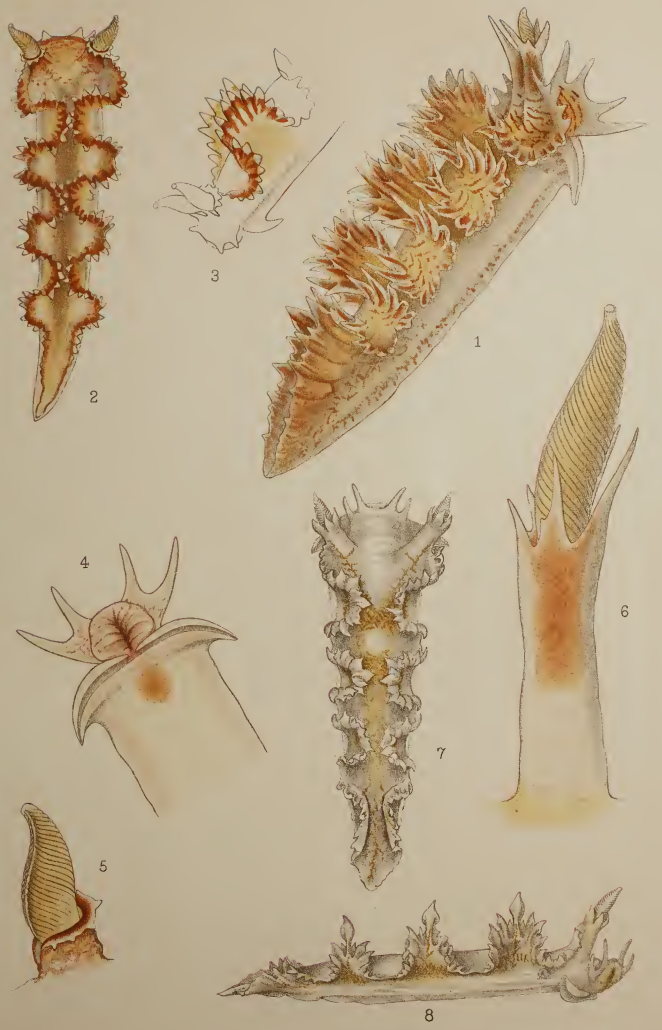
Figs.

1. Lateral view. × about 3.
2. Dorsal view of another specimen. × about 2.
3. Lateral view of head and anterior part of body.
4. Ventral view of ditto.

5 and 6. Two rhinophores showing different shapes of the sheath and its appendages. Considerably enlarged.

The above figures are from drawings by Hancock.

7 and 8. Dorsal and lateral views of an unusually pale specimen captured at Plymouth and drawn by Miss E. Bamford. × 2.



West, Newman chr

1–8. LOMANOTUS GENEI.

PLATE IV.

Hero formosa. (p. 120)

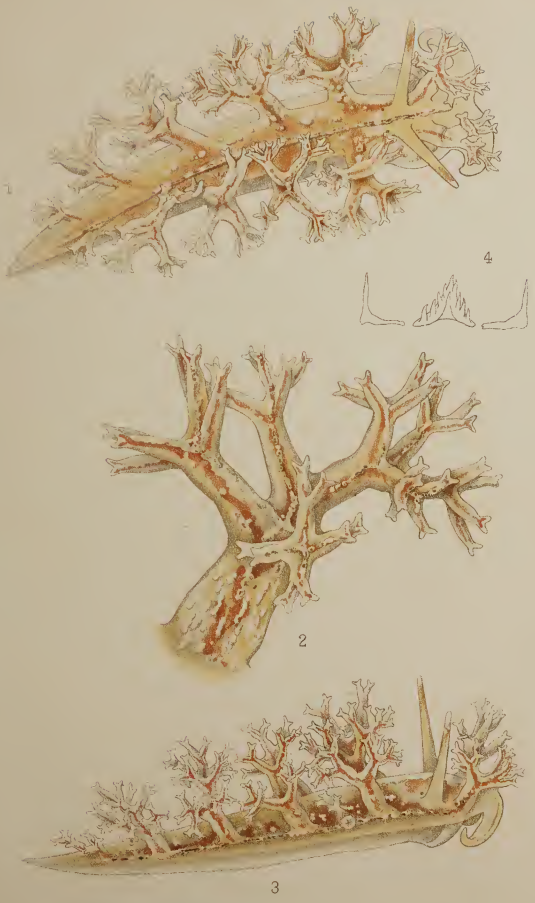
Figs.

1 and 3. Dorsal and lateral views of the whole animal. × 10. (But some specimens are considerably larger than the one from which these drawings were made.)

2. One of the cerata considerably enlarged.

The above figures are from drawings by Hancock.

4. A row of teeth from the radula.



West, Newman chr

1–4. HERO FORMOSA.

PLATE V.

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6. Ditto. One of the cerata. Considerably enlarged.
7. Ventral view of head and crest.

All the above figures are from drawings by Hancock.

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9. Ditto. Diagram of digestive system: *a a a*, the gut and its prolongations into the cerata; *b*, integuments of the body and cerata; *c*, buccal mass; ☿ hermaphrodite gland; *d*, stomachic dilatation.

West, Newman chr.

1-3. DOTO CUSPIDATA. 4-7. JANOLUS HYALINUS.
8-9. CALMA GLAUCOIDES.

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Fig. 3 is from a drawing by Alder. The rest are from drawings by Hancock.

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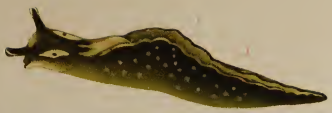
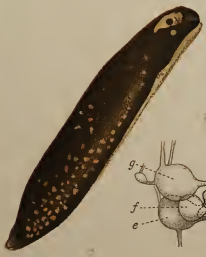
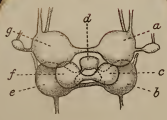
10 and 11. *Cenia cocksi*. (p. 143) Dorsal and ventral views. × 6.

Figs. 1 and 2 are from drawings by Alder. Figs. 3—5, 7—9 are from drawings by Hancock.






d
a
g
c
f
b
e

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8 and 9. *Pleurophyllidia lovéni.* (p. 111) Dorsal and lateral views. Slightly enlarged.

10. Ditto. The central part of a row of teeth. About fifteen of the outer teeth are omitted on either side.

The drawings on this plate were made from living specimens at Plymouth in 1907—8.

West, Newman chr

1–5. CUMANOTUS BEAUMONTI. 6–7. DORIS MACULATA.
8–10. PLEUROPHYLLIDIA LOVENI.

A

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OF THE

BRITISH

NUDIBRANCHIATE MOLLUSCA

BY

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